Engineering Library

MAR 27 1922

March 23, 1922

Engineering News-Record

Devoted to Civil Engineering and Contracting
McGraw-Hill Company, Inc.

American Railway Engineering Association Meeting

Clarification and Activation Features of New Indianapolis Sewage Disposal

From Job and Office

Hints that Cut Cost and Time for Contractor and Average Engineer

Largest Impulse Wheels Feature of the Caribou Hydro-Electric Plant

One of the Double Slung 30,000HP. ImpulseWheels in the Caribou Plant as it Looked Set Up in the Shop.

FINISHED FLOOR AT OFFICE OF A. M. CASTLE STEEL COMPANY, CHICAGO
Note under side of floor showing channel section in photograph below

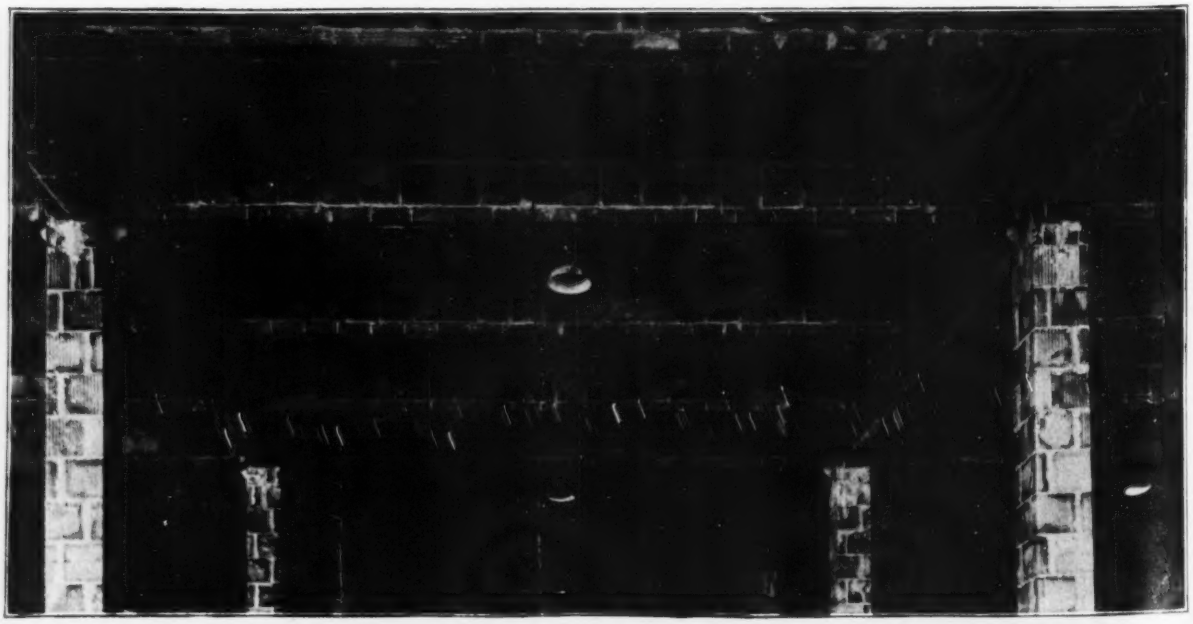
PRE-CAST CONCRETE FLOOR SLABS

Built in channel section to carry any load specified
Lengths to cover the required span

MADE, LAID AND GUARANTEED BY

FEDERAL CEMENT TILE CO.

110 SOUTH DEARBORN STREET, CHICAGO ILL.



A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. MCGRAW, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

Volume 88 — NEW YORK, MARCH 23, 1922 — Number 12

Tablet to Alfred Noble

IT WAS a fine thing for the American Institute of Consulting Engineers to put a tablet commemorative of Alfred Noble in the Engineering Societies' Building. No civil engineer of recent years, probably no civil engineer in American annals, fastened himself so securely in the sympathies of American engineers. He was not merely a great engineer, but a kind-hearted, high-thinking and, above all, a modest man. So outstanding were his qualities that for the last dozen years of his life he was accorded the place of leadership by his fellow engineers with none to dispute his position. Had there been no tablet to him, his engineering works would have proclaimed his greatness, but they could not have told future generations of the esteem and affection in which he was held by his contemporaries. This the new tablet will do. It is an expression of regard that will pass to coming generations the feeling of his own age toward a great American engineer.

The Monument Proposal

LAST week's unveiling of a tablet to Alfred Noble suggests inquiry as to the fate of the project to erect a monument to him in Washington. It was a worthy proposal. It would not only have done honor to one deserving of it, but would have been a symbol of the public service rendered by engineering. We understand that the increase in costs has pushed into the future the realization of the project. It should not be dropped. The tablet in New York does not take the place of the monument. The former speaks only to engineers. The monument would express the importance of engineering to the whole public.

Engineering Memorials

IT IS gratifying to learn that the United Engineering Societies, operating the Engineering Societies' Building in New York, is encouraging the erection of memorials in the building, and that it has adopted rules to insure the maintenance of harmony and of artistic standards. In this country, we are not sufficiently mindful of the past. We have grown so rapidly that precedents have been quickly supplanted. In fact we have prided ourselves that we are not bound by precedent. Undoubtedly it is necessary and wise to adapt ourselves to changing conditions, but nevertheless we stand on the shoulders of the past and daily use its store of knowledge and experience. We should do honor to its achievements, pay our respects to its pioneers and draw inspiration from its victories. Memorials in the societies' building will help accomplish these ends.

Not only are tablets to be encouraged, but other forms of reminders—such as busts and paintings—as well. Events as well as men are to be celebrated. Already it has been suggested that there should be tablets to the engineering regiments which served in the great war—a fitting subject in a fitting place.

There should be a steady response as the years go by to the encouragement of the United Engineering Societies.

Wayside Gravel Pits

GRAVEL production from wayside pits for road building is receiving the fire of commercial producers. They charge that where the practice has been followed, particularly by highway departments doing force account work, true costs are seldom disclosed and that inferior material is produced. Two articles, by J. A. Prior and H. J. Kuehling, published last week and in this issue, touch somewhat on both cost and quality of product from local pits. Production cost is really not a factor of the problem. With freight rates against them the commercial producers have no chance in cost competition with local pits. It is cost of gravel in the road that counts with the highway official and so long as freight rates put a handicap of hundreds of dollars per mile of road on all gravel that has to be hauled by railway car, the probable higher production cost of wayside-pit practices will be regarded with equanimity. There is point, obviously, to the charge that quality is inferior because these local developments have neither the equipment nor the skilled direction of the commercial plants. This chance of inferiority increases as screening and washing become necessary at local pits. Pit practices are not abstruse, however, and there are few instances where gravel production for concrete aggregate cannot be confidently undertaken. In brief, the commercial sand and gravel producer has to accept the handicap of haulage costs which a permanent plant location imposes, or he has to become a peripatetic producer with portable plants moving to where construction is going on. Is not this last alternative the solution of the gravel producer's problem of finding a market in road work?

High-Head Impulse vs. Reaction Wheels

INTEREST in the water wheels installed at the Caribou Plant, described on another page, does not center entirely in the fact that they are the largest impulse turbines ever built but also in the selection of this type of wheel in preference to the reaction turbine, which has so rapidly come to the front of late for high heads. While no reaction wheel has been built for so high a head as at Caribou, the development has been in that direction and such a wheel was seriously considered in this design. Final decision in favor of the impulse wheel was made on account of its probable greater reliability, simplicity and readiness of renewal, in spite of the lower first cost and higher efficiency of the reaction turbine. Where so much power is concentrated in one unit, particularly in a location so remote as is common in the Pacific Coast plants, the considerations that favored the impulse wheel outweigh the gains due to slightly greater efficiency and less cost.

Ingenious Railroad Location

THE way in which the contractor works out the transportation problem on a remote job may easily make the difference between profitable and a losing venture. The need, therefore, for an accurate analysis of transportation conditions increases with the inaccessibility of the scene of operations. While there is room for wide difference of opinion in the solution of a complex transportation situation, fundamentally there is always a right and a wrong way in which to attack the problem. It is always a safe course, for example, to search for and utilize the natural advantages. On the Caribou project, survey parties tried to locate a construction railroad around the face of a high cliff. There were reasons why the line should be kept near a certain level, but construction along this level would be costly and blasting would interfere with the operation of an important power flume that wound around the cliff for 1½ miles at about the same level. In other words, the problem seemed the more difficult because of the flume. However, the plan finally evolved was to build the railroad on a trestle over the flume, thereby avoiding rock excavation altogether and using two miles of flume for floating the trestle timbers, without transportation cost, to the exact spot desired. Often the practical eye will find natural advantages where none are readily apparent but the acme of ingeniousness is to turn to advantage that which at first appears as an obstacle.

An Episode

ROMANCE—that is, the extraordinary, the different, the adventurous—is the commonly accepted perquisite of engineering. Most engineers, to be sure, rarely experience it. Their daily work is as the daily work of other men, pleasant and absorbing if they like and are suited to it, mere drudgery if they have missed their vocation. Once in a while, though, there breaks through the clouds of practicality a ray of pure romance, the kind the story book writers delight to tell about and so few engineers realize. The Caribou job brings one such to mind. The scene is the superintendent's office in the mountain camp at the end of that twenty-mile line of tunnels, reservoirs, inclines and construction road. The telephone rings and word comes that ten miles away in the wettest of the wet tunnels a pump has broken. It is nine o'clock at night and the foreman says that he can keep the water down to safe limits until about four the next morning; if a new part is not in place by then they will have to abandon the heading. The superintendent gets busy on the phone. The machinist, in the main camp, hasn't the broken part but in two hours time he can make one, provided he can get together the men who have gone off work. The construction train is somewhere along the line; it is located and ordered back to the machine shop, with flat car and steam up ready to start as soon as the new part is put aboard. Schedules are rapidly worked out and men assigned to each of the two inclines, shut down for the night, where the car has to be lifted up the thousand or more feet to the upper level. Repair men are rushed to the tunnel itself to put together the broken pump. Meanwhile bulletins from the sump, the machine shop, the inclines and the railroad piece together the procedure that will keep the water down. The activity of many men, all working to a common end, centers here in this little room where one man, seeing the job as a whole, justifies his position as directing head. A common enough episode, perhaps, but of the very essence of engineering and one in which even the prosaic engineer may recognize some of the elements of romance.

Fire Resistance Obligations

EXPOSURE fires of such magnitude as that in the Burlington Building in Chicago are sufficiently rare to cause some concern when they do occur. Queries as to the sufficiency of our fire-protection practice naturally arise when a modern building, which satisfies any accepted requirements of city code or underwriters' rulings, is gutted of its contents in less than an hour. The disposition may well be to inquire whether after all wire-glass should not be required in front as well as in rear exposures to guard against the risk of burning structures across a street. In this, as in all other fire protection questions, a reasonable attitude must be taken. It must be recognized that absolute protection against fire is impossible and that the ideal fire-resistant vault cannot be duplicated in a building in which people must live or work. Furthermore there is an economic limit beyond which protection against the occasional danger cannot be carried. Wire-glass on street fronts would decrease exposure risk but whether enough to warrant its imposition by law is certainly doubtful. Rather does it seem that improvement in codes and laws must be expected in the removal or restriction of those structures which menace their better built neighbors. Is it wiser to require the owner to erect a building safe against any possible danger that his neighbor may invite, or *all* owners to reduce the hazards to which they subject adjoining property?

Rates a World-wide Problem

AMERICAN railroad men will be interested to learn that their British brethren are grappling with problems very like their own. British business men are now working for a reduction of railway rates to a general level 50 per cent above prewar figures with rates on small lots 100 per cent above prewar. The railways would like assurance that such reductions will stimulate traffic. They are told that the lower rates *may* stimulate traffic but that the present rates will, in all probability, take away some that they now enjoy. This "assurance" does not seem to have aroused great enthusiasm on the part of the railways. Freight in the United Kingdom is seeking the highways. Hardware, we are told, is now being distributed from Manchester by road up to a distance of 40 miles. Cotton in large volume travels by road from Liverpool to Manchester. Dundee firms have diverted from 25 to 80 per cent of their traffic to sea and highway. So great have these defections become that the railways are now pressing for authority to engage in highway transportation. This is opposed by some of the business organizations but there seems to be a feeling that such a step would be reasonable and might lead to an effective co-ordination of rail and highway transportation that would make for the general economic advantage. Sooner or later we too shall find ourselves turning toward the creation of a national transportation machine that will link up effectively, each in its proper place, the railroads, the waterways, and the highways of the United States.

Staking Out the Airways

IN THE March 2 issue of the *Engineering News-Record* it was reported that the board of directors of the Chamber of Commerce of the United States had authorized the appropriate department of the chamber to urge legislation looking to the promotion and regulation of commercial air transportation. The personnel of the advisory committee that recommended this action appears to indicate that it is the product of hard-headed business thought rather than of visionary enthusiasm. That the step is timely is indicated by the almost simultaneous announcement of a corporation which plans to engage in air transportation on a large scale as a commercial enterprise. Sooner or later, of course, air transportation must submit to the yoke of federal regulation. Much is to be gained, therefore, by laying down now a broad and soundly conceived foundation upon which to develop as the industry progresses an effective code of air regulations designed to meet both governmental and commercial requirements. Such a course will make for genuine and uninterrupted progress and will make it possible to avoid a repetition of the harrassing and wasteful confusion that has attended the imposition of governmental regulation on our railroads and other public utilities. In such matters the stitch in time may save ninety and nine.

Changes in Sewage-Works Plan at Indianapolis

ALTERED conditions of financing and increased knowledge of sewage treatment no doubt contributed largely to the decision of the Indianapolis Board of Sanitary Commissioners to treat screened sewage by the activated-sludge process—but for only half of the year—instead of adopting filters and humus tanks for the secondary process, as advised by George W. Fuller in 1917. C. H. Hurd, in an article elsewhere in this issue, estimates that the change will save $1,000,000.

Mr. Hurd's experiments on barrel screens, placed tandem, three in a channel, followed by a concentrate or sludge thickener, have convinced him that 30 per cent of the solids can be removed if the sewage comes to the screens without pumping or other undue agitation. His apparatus is old in the paper mill industry. Mr. Fuller estimated a 10-per cent removal by screens, although he stated that higher percentages of removal were possible with sewages containing trade wastes carrying suspended matter of relatively large size, a condition usually existing in Indianapolis sewage because of the packing-house industry.

Full advantage has been taken of the fact, which Mr. Fuller recognized, that the White River can care for a clarified sewage half the time. Closing down the activated-sludge plant half of the year will reduce operating costs by saving aeration charges and will simplify the sludge-disposal problem. Moreover, the plant has been so designed that no pumping is necessary to put the sewage through the screens or primary clarification process.

Five years ago much was made of the recovery of nitrogen. Now with a dull or no market for fertilizer and the sludge-drying problem not fully solved, it is significant that the activated-sludge treatment is still looked on with favor. The numerous engineers who have stood on the banks of the Houston Ship Channel at the outlet weir of the activated-sludge plant at Houston, Tex., and noted the crystal clearness of the effluent, could not but be favorably impressed regardless of the fact that the sludge dewatering and fertilizer-recovery problem had not been solved.

The Indianapolis results with both the new type of sewage screens and the activated-sludge process will be awaited with interest by the sanitary engineer. Interest is heightened and expectations increased by the fine laboratory and experimental equipment wisely provided by the Board of Sanitary Commissioners.

Morris Canal Abandonment and New Jersey Water Supplies

ABANDONMENT of the Morris Canal in New Jersey, provided for in legislation noted in this week's news section, means more than the final obsequies over another disused inland waterway. Wisely and justly consummated, the negotiations for abandonment would greatly simplify some of the business and political factors entering into a solution of the water-supply problems of the New Jersey Metropolitan District in accordance with any one of three of the four plans outlined in the report by Allen Hazen, abstracted and commented on editorially in our issue of March 16. Canal abandonment in favor of the state would increase the safe yields from these projects, since because of the canal claims Mr. Hazen's estimates were lessened by amounts which, although small compared with his totals, are considerable daily quantities of water.

More significant than the amount of water involved is the removal of a long-standing source of contention in the State Legislature and in the municipal water problems of northeastern New Jersey that would result from a wise and just outcome of negotiations for the abandonment of the Morris Canal. Such an outcome would give the State of New Jersey and its most important group of municipalities a better chance than has existed since the failure to adopt the recommendations of the State Water Supply Commission report of 1884 to work out a joint water-supply project that would provide adequately and cheaply for the needs of the New Jersey Metropolitan District for 50 to 100 years to come. This would need to be followed by the acquisition for the district of sources af water supply developed and now owned and operated by the East Jersey Water Co. and its associates, partly under cover of these very Morris Canal rights. These private interests are entitled to just compensation for doing what the state and the municipalities failed to do in the way of providing water supplies. It is believed by many that attempts to monopolize the water supply of the New Jersey Metropolitan District have not been so profitable as was expected and that this, together with the gradual extension of the state control of sources of water supply and of charges for water, combine to make the allied interests quite willing to accept a fair value for their water properties in northeastern New Jersey.

The New Jersey situation presents an opportunity for broad-minded co-operation by state and municipal interests on the one side and private interests on the other to end a conflict that has lasted forty years and that should no longer be continued in a field so important to municipal life, health and prosperity as that of public water supply.

High Head Impulse Wheels at New Feather River Plant

Caribou Hydro-Electric Plant in California Has Two 30,000-Hp. Impulse Turbines Under 1,008 Ft. Head—Water Brought From Headwater Reservoir by Tunnel, River and Pipe

In the Caribou hydro-electric plant on the Feather River in California there is an excellent example of Western water-power practice, both in the pioneer nature of the construction and in the development of flow and head through a series of reservoirs and tunnels. The plant is described here in two articles, the first on the general features by a member of the staff of the firm which designed and built it and the second, on the complications surrounding the early construction, by a member of the staff of this journal. In the "From Job and Office" section of this issue will be found some further notes on the construction of the plant.—Editor.

General Features of Design of the Caribou Plant

BY ALBERT A. NORTHROP
With Stone & Webster, Inc., Boston, Mass.

AS A PART of the consecutive development of the Feather River in California the Great Western Power Co. has recently completed the initial development of the Caribou hydro-electric plant by the installation of two 30,000-hp. double-hung impulse turbines operating under 1,008 ft. head. The final capacity of the power house will be six similar units. The work included building a dam, driving two tunnels and the construction of an inclined penstock, partly in pipe line and partly in tunnel as well as the construction and equipping of the power house proper, all in a remote district to which new railways and roads had to be built.

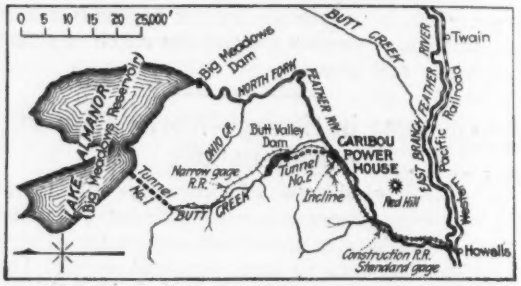
The Feather River, second largest in potential power of the four big California streams, rises in the Sierra Nevada Mountains in Plumas County, some 200 miles north of San Francisco. It flows west and then south for 140 miles until it joins the Sacramento in the broad and gently sloping Sacramento Valley. The upper half of the stream contains about 640,000 potential horse power in a total fall of a little less than 5,000 ft. A mining venture was the forerunner of the first Feather River power plant. To furnish water under a high head for hydraulic sluicing operations, a tunnel was driven through the mountain to connect the two ends of a great bend of the river. When California made hydraulic sluicing unlawful, in order to save her rivers from filling with silt, the Great Western Power Co. purchased the tunnel, together with the water rights. At this site they built the Big Bend hydro-electric station in 1909 with an installed capacity of 87,000 hp.

Four years later a storage reservoir, holding 300,000 acre feet, was created high up in the mountains to regulate the flow of the stream near its headwaters. An earth dam was built across the north fork of the river at a place called the Big Meadows, about 35 miles up stream from the Big Bend plant. There, at an elevation of approximately a mile above the sea, a reservoir called Lake Almanor, was formed covering 15,500 acres of almost level ground. The lake is fed from a drainage area of 504 square miles of snow topped mountains.

With this great store of water an accomplished fact, the development of the entire stream became commercially attractive. Seven power plants are planned, which will utilize 85 per cent of the 4,285 ft. fall in the 75 miles from the Big Meadows reservoir to Oroville, and will develop a total of 640,000 hp.

The Caribou plant, the second of these, is about 25 miles above Big Bend and 10 miles below Big Meadows reservoir. It is some 200 miles north by northeast of San Francisco near the main line of the Western Pacific Ry. at Belden, Plumas Co., Cal. A ten-mile construction railroad runs from this station to the power house.

The plant has an installed capacity of 60,000 hp. with space provided for another 30,000-hp. electric unit in the present power house. Eventually the power house will be doubled, additional tunnels driven and a total of 180,000 hp. developed at this location.



LOCATION OF CARIBOU TUNNELS AND POWERHOUSE

As stated, the water is led from the Big Meadows reservoir to the power house by means of tunnels. The first tunnel taps the floor of the reservoir and leads the water under about 250 ft. of cover to a neighboring valley. Here it discharges from the tunnel and joins the existing creek, flowing with it for six miles of gentle slope until it reaches the lower end of a broad expanse of meadow land into which the valley widens. Where the valley narrows again, just before the stream plunges into a steep walled canyon, a simple earth-filled dam is placed. This forms the Butt Valley reservoir some two miles in length from which the water passes into the second tunnel, leading direct to the power house and the wheels.

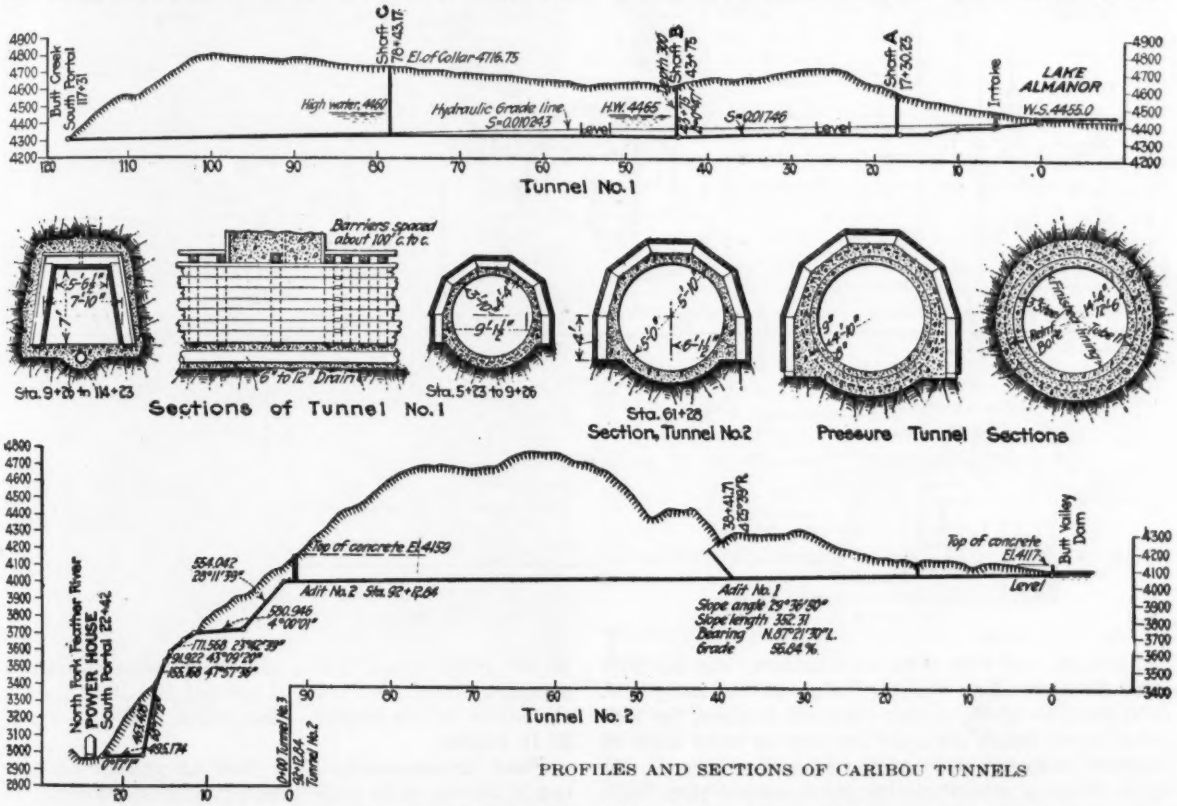
The general layout of the project then is first, the two mile tunnel, which taps the lake; a conveniently located valley that serves as an open canal for six miles; a small earth dam to form a secondary reservoir; a second tunnel, also about two miles long, and at its lower end the penstock and power house.

Big Meadows Reservoir.—The Big Meadows reservoir, Lake Almanor, was created in 1913, four years after the construction of the Big Bend plant. It was made by sluicing into place an earth dam 600 ft. long. This formed a lake with a surface area of 15,500 acres, an average depth of 19.5 ft. and a capacity of 300,000 acre feet. The topography at the dam site will permit the crest to be raised 28 ft. higher. This would provide for storage of 1,250,000 acre feet with a surface area of 27,000 acres. The average yearly run-off from the 504 square miles of drainage area above the dam is 842,000

acre feet, so that raising the dam to the full additional height of 28 ft. would only serve the purpose of conserving the occasional floods and thus obtain a more nearly uniform flow.

At the time of creating the reservoir, the question of its probable water-tightness was carefully investigated. The rock in this general region is broken and is far from water-tight. It was found, however, that the volcanoes of the region had spread a blanket of volcanic ash from 8 to 10 ft. thick and so extremely fine as to be water-tight. With this impervious covering to line the reservoir and a safe earth dam, unusually broad of base, the success of the reservoir was assured.

Tunnel No. 1.—Tunnel No. 1, leading from the reservoir to the intermediate valley, is 11,200 ft. long with



PROFILES AND SECTIONS OF CARIBOU TUNNELS

an area of 46 sq.ft. and is approximately rectangular. It has a slope of 1 per cent and a capacity of 800 sec.-ft. The tunnel has a concrete floor but above this it is timber lined. Concrete collars for water-breaks are built at suitable intervals to prevent a velocity developing behind the timber lining. A gate at the lower end, regulating the flow through the tunnel, insures its always being full of water to preserve the timbers from decay. About 700 ft. of the tunnel through disintegrated sandstone was lined with concrete instead of timber. The flow from the lake is controlled by a 7-ft. electrically-operated gate at the tunnel entrance.

The course of this tunnel passes from the country rock of slate into what was, in prehistoric times, an open valley but which centuries ago was filled with lava. Upon cooling, this lava opened up in myriads of cracks so that the river, once flowing in the valley below, now finds its way through the countless cracks in the lava itself. It was in material of this kind that much of the tunnel was driven.

Even before the headings were started from the shafts, trouble was anticipated from water accumulating at the downstream headings. To provide against this the junction point was estimated where the headings from two adjacent shafts would probably meet. The up-hill shaft was then sunk below the hydraulic gradient far enough so that the tunnel could be driven with no grade at all from this up-hill shaft to the estimated meeting point with the tunnel coming up hill along the hydraulic gradient from the shaft down hill. As this level portion was all below the hydraulic gradient, the efficiency of the tunnel was not impaired and the infiltering water was made to run away from the heading to the upstream shaft without being pumped.

Once at the shaft, the water was handled by electrically-driven pumps with a reserve set of steam pumps held in readiness to start up on five minutes' notice. At one shaft alone, 5,000 gal. per min. were pumped to the surface against a head of 250 ft.

Tunnel No. 2.—The water which discharges from Tunnel No. 1 flows down a small valley for six miles, where a simple earth dam directs it into the second tunnel which leads to the brink of the gorge above the power house. The dam is about 30 ft. high and consists of two parallel embankments of tunnel waste, dumped from trestles and filled between with fine materials sluiced from the adjacent hillsides.

A concrete spillway carries the flood waters around one end of the dam and at the other end the water is admitted to the tunnel through a 9-ft. electrically-controlled sluice gate installed in a reinforced-concrete gate house.

The tunnel is a circular concrete tube 10 ft. in diameter with an area of 78.5 sq.ft. and a capacity of 1,350 sec.-ft. Its length is 9,200 ft., with slope of 0.8 per cent.

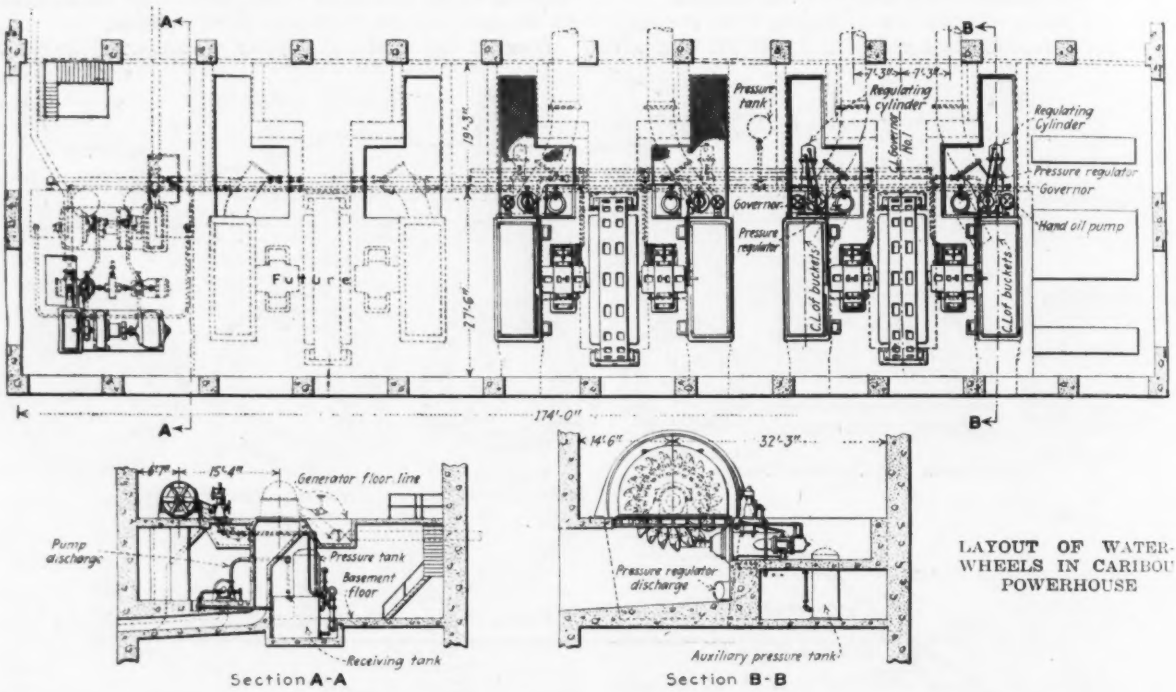
Pressure Tunnel and Penstock.—At the crest of the gorge, the second tunnel merges into a circular pressure tunnel 9 ft. 8 in. in diameter with an area of 73.4 sq.ft. and a length of 550 ft. It is built of concrete, heavily reinforced, for both inside and outside pressures. To insure absolute water-tightness a diaphragm of ⅜-in. steel is imbedded as a central core in the circular concrete wall. It is in effect a thin steel pipe with an inner and outer concrete cover, each heavily reinforced.

When driving the tunnel, timbering was put in where necessary, leaving sufficient clearance for a concrete lining with an outside diameter of 14 ft. The steel pipe, ⅜ in. thick and 9 ft. 8 in. in diameter, was set first using 30-ft. sections and beginning at the lower end. With the first 30-ft. section fastened in place, the pipe served as an inside form for the first or outer layer of concrete lining. Some bracing was necessary on the inside of the pipe and for this purpose wood rings were used, thus making it possible for workmen to climb through the inside of the pipe during this stage of the work. The concrete outside the pipe was poured with a minimum thickness of 12 in. and was reinforced where the rock walls were weak enough to require it. When this concrete had set the wood rings were taken out and a cylindrical form was built up inside the steel pipe, beginning at the bottom and extended a section at a time. This was braced so as to give a clearance of 8 in. between form and pipe. The inner shell of concrete was then poured.

Concrete was supplied from a mixing plant at the top of the incline, whence it flowed into place through chutes run down the tunnel. The bottom of the pressure tunnel terminates in a concrete plug from which three steel penstocks continue downward. One of these is a stub capped for the future installation of another 30,000-hp. unit. The lower end of the steel pipe in the pressure tunnel was imbedded in this stub poured monolithic with both inner and outer concrete in the tunnel.

This reinforced-concrete pipe changes into two steel pipes as it nears the surface of the hillside. Each of the two steel pipes is 1,335 ft. long and 66 in. in diameter with the steel ranging from ⅝ to 1⅛ in. in thickness. Owing to the looseness of the material on the hillside back of the power house, these pipes are on the surface for only 520 ft., disappearing into a shaft 550 ft. deep. It is built on a slope of one horizontal to two and a half vertical. In it the 66-in. pipes divide into the 42-in. pipes which go directly to the wheels.

A surge tank 30 ft. inside diameter is built as a concrete shaft in the hillside rising from the junction of the grade tunnel No. 2 and the reinforced-concrete pressure tunnel. Its crest at present is 1,130 ft. above the center of the nozzles. Eventually it will be raised 35 ft. higher.



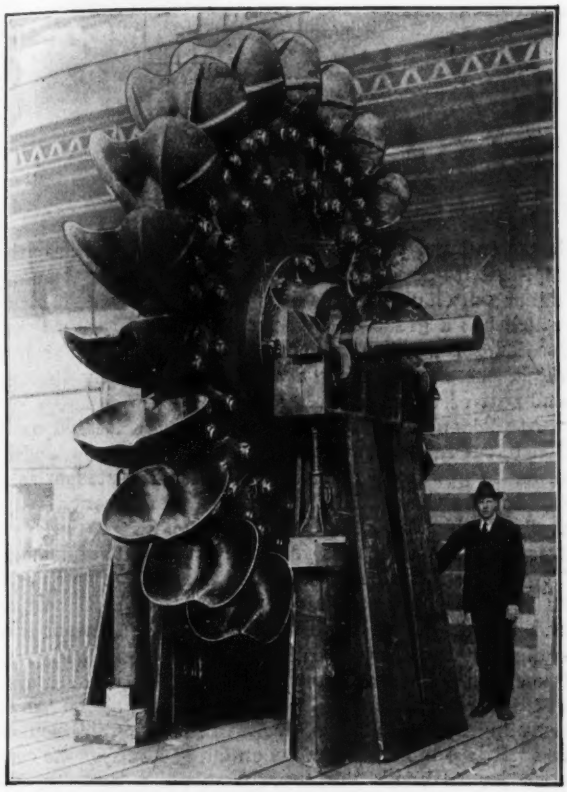
LAYOUT OF WATER-WHEELS IN CARIBOU POWERHOUSE

Plant Arrangement.—The plant at present contains two 30,000-hp. units with space provided and foundation in place for a third unit. The exciter units are placed at one end of the building. In the final installation the power house will be extended and the exciters will then have three units on each side, making the final layout symmetrical. Each present unit consists of one 30,000-hp. generator and two overhung impulse wheels. Each wheel has a capacity of 15,000 hp. and is driven by an 11-in. jet issuing from a fixed needle nozzle. There are but two bearings in the unit. They carry the generator rotor between them while the wheels are carried on the overhang of the shaft just beyond each bearing. The over-all dimension of the unit occupies a floor space of 30 x 40 ft.

Impulse Turbines.—Although the impulse type of wheel was chosen, the Francis type, or reaction wheel, was seriously considered, as the manufacturers stood ready to furnish reaction wheels to operate under a 1,000-ft. head. The choice of the impulse type was made only after a careful comparison of the advantages of the lower first cost, smaller floor space and higher effi-

ciency offered by the reaction type, as against greater simplicity, smaller liability to wear and greater ease in renewing worn parts inherent in the impulse type. The more rugged impulse type won.

Each wheel, without the shaft, weighs 25 tons. It is equipped with 21 cast steel buckets each 36 in. wide and each weighing 1,000 lb. They are all balanced as to weight and to position of the center of gravity. Before leaving the shop each wheel was fully assembled to test it for balance and so accurate had been its construction



ONE OF THE IMPULSE WHEELS ON THE 30,000-HP. CARIBOU UNIT

that a 2-in. nut placed in a bucket on one side caused a complete revolution of the wheel.

The disc is approximately 11 ft. in diameter, 7 in. thick, and is made of oil tempered forged steel of special high tensile characteristics. It is pressed on a cast-steel hub and bolted to it by means of reamed bolts, each machined for a pressed fit of 50 tons. The hub in turn is finally pressed on the shaft with a press fit of 200 tons and is keyed and locked in place.

The shaft is compression forged of open hearth steel, having a tensile strength of 75,000 lb. per square inch. It was given special heat treatment and was hollow bored to insure perfectness of metal. It is 30 ft. long with a maximum diameter of 30 in. and a diameter at the bearings of 24¾ in. It weighs 26 tons, having been made from a 50-ton billet.

The shaft is supported in two heavy-duty bearings, each carrying 200,000 lb. under full load conditions. They are of the self-aligned babbitted type with heavy oil rings and water cooled shells. They are also equipped with forced feed which may be used in emergency or put into continuous service if necessity demands. The bearing is 24¾ inches in diameter by 72 inches in length.

The wheels, which revolve at 171.4 r.p.m., are entirely independent in their control. Each has its own needle control, oil-pressure governor, pressure regulator and gate valve. The only point in common is that the fly balls of the governors are driven from the same shaft. The governors are of the oil pressure type, equipped with relay for hand operation and remote electrical switchboard control, load limiting device to enable carrying constant load irrespective of the load demand, and safety stop which closes the nozzles in case of breakage of the belt driving the speed governor.

The nozzles are of the stationary type, needle controlled, and with steel and bronze wearing rings throughout. The needle tip and nozzle throat rings are readily renewable. The needle stem extends directly backward to form the piston rod of the regulating cylinder. The nozzle body is of cast steel tested to 750 lb. per square inch. The disruptive force tending to separate the flanges of the nozzle hood is more than a half million pounds. The nozzle opening is 13 in. in diameter. The inlet is 38 in. inside diameter and is connected to the penstock by a long radius elbow expanding to the penstock diameter of 42 in. An hydraulically operated 42-in. valve is located on each 42-in. penstock line just outside the power house.

Water hammer, or increased pipe-line pressures, are controlled by a pressure regulator connected to the inlet pipe back of the nozzle, which is operated by the governor directly and can be arranged to act as a synchronous by-pass or a water saving device.

The plant was designed and built by Stone & Webster, Inc., of Boston, through S. L. Shuffleton, its western manager. William N. Shannon and E. C. Macy were superintendents of construction.

Transportation Problem Paramount in Plant Construction

IN LAYING out a construction program for the Caribou hydro-electric development, every endeavor was made to get camps established and have the labor forces organized before the winter of 1919. Although at an altitude where there is some snow throughout the winter, the weather is ordinarily such that a good deal of work can be done in the winter months, provided camps and sources of supplies are established before the rainy season begins. As the country involved is very rough, and for the most part did not even have trails that pack animals could use, the first necessity was a construction railroad. Alternate routes were surveyed and it was finally decided to build four separate railroad lines on different levels connected by inclines at four convenient points.

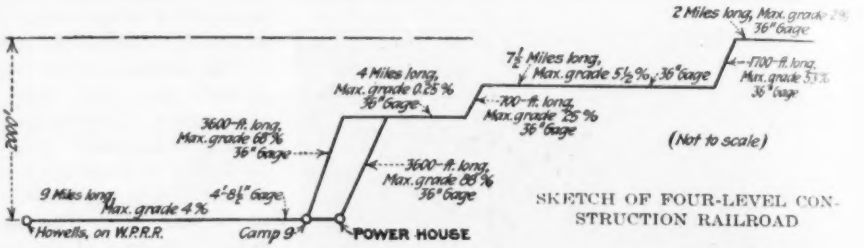
While problems connected with locating this transportation system were being worked out, twelve camps were located along the 24-mile stretch from Lake Almanor, the upper end of the conduit line, to the railroad station at Howells where it was decided to establish railroad connection at the lower end of the project. As soon as supplies could be delivered by pack trains or otherwise, these camps were opened and several hundred men were put to work at the critical points.

Spur From Main Railway.—The first important determination was the location of construction headquarters for the entire job at Camp Nine, about half a mile from

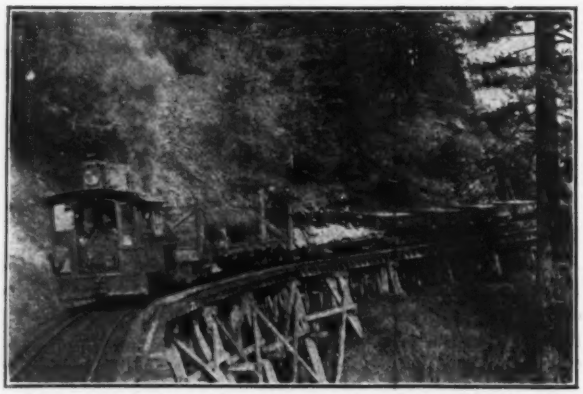
the power house site and 9 miles up the north fork of the Feather River canyon from Howells. The Western Pacific R.R. follows up the north fork of the Feather as far as Belden, where it leaves it to turn into Indian River canyon. Decision was made to build a 10-mile broad-gage line from Belden on up the north fork and directly into the power house, so heavy machinery could be delivered to the overhead cranes without rehandling. All the rest of the construction railroad system was made narrow-gage.

The disadvantage of having equipment on the job for more than one gage was offset by the fact that the narrow-gage lines are accessible only by inclines and only special equipment, of whatever gage, could be taken over these inclines, that is, the cars require special freight stops, called strong-backs, at the rear end, as well as slings in place of the ordinary coupling. Distinct advantages of using narrow-gage on the upper levels were (1) less first cost, (2) less time for construction, (3) easier location in rough country than would be the case with broad-gage and, (4) lower capacities in hoists than would have been required for handling broad-gage equipment (the hoists have a capacity of 20 tons).

In order that narrow-gage cars could also be taken to the power house from the upper levels, a third rail was


2000'
9 Miles long, Max. grade 4%
4'-8½" Gage
Howells, on W.P.R.R.
Camp 9
3600-ft. long, Max. grade 68% 36" Gage
4 Miles long, Max. grade 0.25% 36" Gage
7½ Miles long, Max. grade 5½% 36" Gage
700-ft. long, Max. grade 25% 36" Gage
3600-ft. long, Max. grade 68% 36" Gage
2 Miles long, Max. grade 36" Gage
1100-ft. long, Max. grade 36" Gage
POWER HOUSE
(Not to scale)

SKETCH OF FOUR-LEVEL CONSTRUCTION RAILROAD



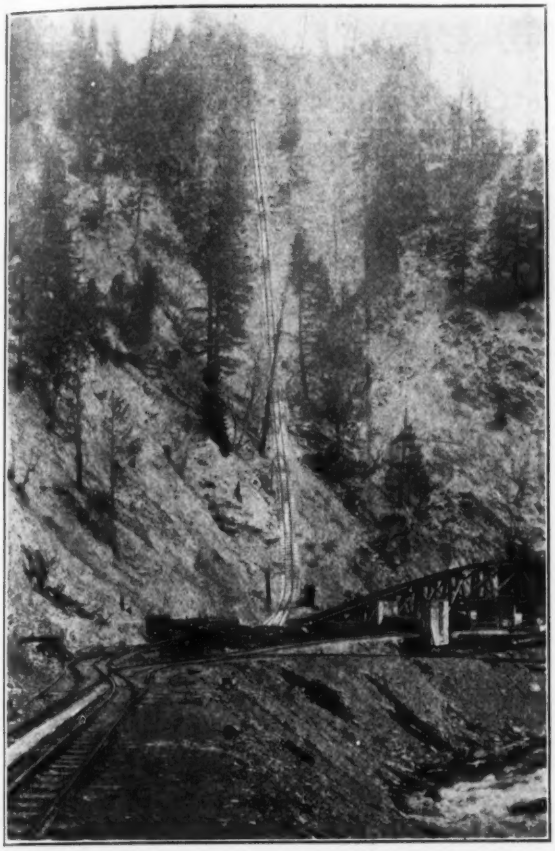
NARROW-GAGE CONSTRUCTION TRAIN ON OLD BUTT VALLEY FLUME

laid on the ties from the foot of the narrow-gage incline at Camp Nine to the power house site. Thus a saw-mill on the upper end of the work, built for supplying lumber for construction purposes, was able to deliver lumber for concrete forms and timber for the penstock tunnel without rehandling. Exclusive of the inclines, the railroad system comprised 10 miles of standard-gage track and 11 miles of narrow-gage line. The broad-gage had a maximum grade of 4 per cent and 45-deg. curves. On the narrow-gage the grades ran up to 5½ per cent and curvatures as low as 80-ft. radius were used. Fifty-pound rails were used throughout both systems. The contractor's railroad equipment included six 18-ton narrow-gage locomotives and 48 narrow-gage cars, as well as five broad-gage locomotives ranging from 35 to 50 tons in weight.

Locating Inclines.—Because the narrow-gage line had to connect the intake and the penstock line, passing Butt Valley dam and the saw-mill en route, the questions of where the two upper inclines would be located was largely determined by topographical conditions. In the case of the incline at Camp Nine, however, selecting the best location was not a simple matter. Several possible locations were surveyed and it was finally decided worth while to build more than a mile of additional track on the level above in order that the incline might follow up a ridge or "hog-back" that afforded a steeper slope at the lower end and avoided precipitous rock ledges near the top. At its upper end this incline terminates at an old miner's ditch used in the days of the 1849 gold rush and which has a grade of 0.25 per cent. The railroad was located for 2 miles to follow the bench built for this ditch, thereby effecting a considerable saving in time and cost of construction.

At Belden the Western Pacific R.R. is located on a bench, cut in the south side of a narrow canyon, and in order to get the branch line down to the stream so a crossing to the north fork could be made economically, two switchbacks had to be built almost entirely on trestles. These trestles required 500,000 ft. of lumber. To get this branch railroad in to Camp Nine as quickly as possible, work was also carried on from the upper end, working down the canyon. Doing this meant that equipment and supplies used at the upper end had to be transported 40 miles from the railroad. In the course of this circuitous trip they were rehandled eleven times, traveling by boat, teams, pack-trains and over inclines and newly completed sections on upper levels of the construction railroad. This program paid, however, because when the track-laying crews met, two miles of the broad-gage line had been built down the canyon from the upper end. The 10-mile line was put in service for freight deliveries direct to Camp Nine, in 100 working days. The endeavor to make speed on the project was such that by the time the Howells-Camp Nine railroad was completed, about 2,500 tons of freight had been brought in via the 40-mile barge, truck team and pack-train route. This included materials and supplies for camps that toward the end of this period, accommodated 1,000 men. In order to relieve the strain on this limited means of transportation, freight was occasionally shipped from San Francisco via Reno, Nev., to a branch line terminal at Westwood, thence across Lake Almanor by boat and finally by truck and pack train direct to the several camps.

Railroad on Flume.—A short distance up the canyon from the top of the power house incline, a flume serving the Butt Creek power house winds around the brow of a high cliff, more than a thousand feet above the stream. This flume and power house were built about ten years ago to serve the construction of the Big Meadows dam. After searching in vain for any economical route for the construction railroad, which was required at about the same level as the flume, decision was made to build the



LOOKING UP THE INCLINE AT THE POWER HOUSE

railroad on top of the flume, erecting a timber trestle around and over the flume structure to support the track. When the flume was built labor and materials were less expensive than at present and fortunately, considerable blasting was done so that the flume had ample clearance. Locating the railroad on top of the flume made it unnecessary to do any heavy blasting along the line, which would have been undesirable from the standpoint of expense and also because it was important not to interfere with the flow of water in the flume.

This solution of the problem had another advantage in that the saw-mill was located not far from the upper end of the flume and timbers for the trestle were floated down the flume, thereby being delivered free of transportation cost where needed.

Sand and gravel for the power house had to be brought in by rail from Oroville, 85 miles away. No suitable material was found anywhere in the Feather River canyon, but fortunately a good gravel deposit was found in Butt Creek Valley and a gravel washing plant established there which supplied sand and gravel to all parts of the work down to and including the upper end of the penstock line. When it came to delivering these materials over the long incline to Camp Nine and thence to the power house, the cost delivered was found to balance that of the Oroville materials, and the latter were used to avoid congestion on the construction railroad.

Shandaken Tunnel Progressed Nine Miles During 1921

DURING the year 1921, driving from 12 headings, a progress of 47,367 lin.ft. was made by the Ulen Contracting Corp. on the 18-mile Shandaken tunnel of the Catskill water supply system for New York City. The tunnel will be lined with concrete and will have finished inside dimensions of 10 ft. 3 in. in width and 11 ft. 6 in. in height. The year's work represents 291,772 cu.yd. of rock excavation and 5,845 heading shots, averaging 8.1 ft. per shot.

Shaft 1 was on a two-shift basis for the entire year, two shots being made in each heading every 24 hours. At Shaft 3, three heading shots were made each day with the exception of the month of October, when two shots per day in each heading were made. Shaft 4, until Aug. 1, was on a swing-shift basis, three shots being made at the shaft every 24 hours, but after this date two shots in each heading were made each day. Shaft 5 was on a swing-shift basis until Oct. 1 and after this date was on a two-shift basis in each heading. Shaft 6, due to timbering and unstable rock, has been on a swing-shift basis for the entire year, three shots being made every 24 hours at this shaft. At Shaft 7 one shot was made in the north heading and two shots in the south heading each day. Work was carried on continuously for the entire year excepting holidays. No work was done on the day shift on alternate Sundays.

The maximum monthly progress for any heading on a two-shift basis was made in the north heading at Shaft 3 during August when 593 ft. was driven in 58 shots, giving an average advance of 10.22 ft. per shot. During the same month the south heading at this shaft, which was on a single-shift basis, advanced 346 ft. in 29 shots or 11.29 ft. per shot. Several shots were made in this heading which exceeded 14 ft.

The accompanying table gives the details of the year's operations, which were under the direction of Thomas S. Shepperd, general manager for the Ulen company.

SHANDAKEN TUNNEL PROGRESS IN HEADINGS FOR YEAR 1921

(*Unit for heading advance is feet*)

	Shaft 1		Shaft 3		Shaft 4		Shaft 5		Shaft 6		Shaft 7		Totals		
1921	North	South	North	South	North	South	North	South	North	South	North	South	Progress	No. Head'g. Shots	Average Per Shot
January	360	374	101	94	.....	.....	188	224	214	228	130	246	2,159	328	6.58
February	383	349	92	104	.....	.....	206	236	195	230	110	207	2,112	327	6.46
March	439	359	186	201	.....	.....	303	216	217	253	120	334	2,628	400	6.57
April	430	399	265	203	60	68	276	316	256	240	170	386	3,069	443	6.93
May	406	422	419	200	163	166	283	323	290	255	217	433	3,577	503	7.11
June	373	440	477	263	321	309	324	324	316	322	236	472	4,177	554	7.54
July	537	509	509	306	333	363	299	321	286	326	232	440	4,461	518	8.61
August	587	537	593	346	492	410	353	349	333	322	250	493	5,065	565	8.96
September	513	524	329	409	510	328	283	339	316	330	251	519	4,651	522	8.91
October	426	548	455	479	480	443	405	457	379	381	263	534	5,250	577	9.15
November	449	521	384	387	465	530	414	452	357	367	277	579	5,182	565	9.17
December	513	538	406	374	437	538	435	492	289	313	263	438	5,036	543	9.23
Total advance	5,416	5,520	4,216	3,366	3,261	3,155	3,769	4,049	3,448	3,567	2,519	5,081	47,367	.....	.....
No. heading shots	661	657	476	393	398	384	496	512	473	481	299	615	.....	5,845	.....
Av. ft. per shot	8.19	8.40	8.86	8.56	8.19	8.22	7.60	7.91	7.29	7.42	8.44	8.26	.....	.....	8.10
Lin. ft. permanent timber	601	None	1,040	1,985	21	1,290	3,090	1,785	All	All	All	1,101	20,447	.....	.....

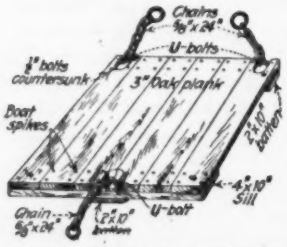
FROM JOB AND OFFICE

Hints That Cut Costs and Time — *For Contractor and Average Engineer*

Plank Skip Carries Fifty Sacks of Cement

BY G. W. MCALPIN
Huntington, W. Va.

A USEFUL flat cement-skip is shown by the accompanying sketch. The deck of this skip is of 3-in. oak plank boat-spiked to sills 4 x 10 in. One ½-in. bolt in each corner adds stiffness. Instead of links short chain lengths are used to provide fastening for a three-way chain. The U-bolts to which the chains are attached are set in recesses large enough to permit the chains when slacked off to fall flush with the deck. In this way no obstacle which might tear the sacks is presented when the skip is dumped. The short chains, being pliable, will also pull out from under a pile of sacked cement more readily than the old style link. The heads of the U-bolts are protected by 2-in. oak battens, which prevent them catching and tearing the sacks when the skip is landed on a pile. The three chains are of the same length and fasten by means of a large link to the hooks of the usual three-way chain. The length of the chains permits the hook in the three-way chain to clear the top of the pile. A load of 50 sacks of cement is usually carried on the skips but as many as 100 sacks have been carried without straining it.



PLANK SKIP FOR SACKED CEMENT

Concrete Pavement Cut and Broken Up With Improvised Machines

BY JULIAN MONTGOMERY
City Engineer, Wichita Falls, Tex.

IN JULY, 1921, the City of Wichita Falls, Texas, granted the Wichita Falls Traction Co. permission to lay 4,000 ft. of track through one of the business and residential sections of the city. For about 3,400 ft. of the distance the street is paved with 6-in. two-course concrete containing light hog wire in the bottom course as reinforcement. The other 600 ft. is paved with 3-in. wood block on a 5-in. concrete base. The laying of the track therefore involved the removal of a 7-ft. strip of pavement and repaving after the track had been laid. The city issued instructions that precautions be taken against the injury of the pavement on either side of the track strip. These instructions specifically prohibited breaking up the 7-ft. strip until it had been cut free from the pavement, though it was decided a cut through the 2-in. top course would be sufficient.

FIG. 1—IMPROVISED CHISEL CUTS 2-IN. CONCRETE

Pavement Cut. — The work was let to a local contractor who felt that hand picking or hand chiseling would be too expensive so he rigged up a concrete mixer with an automatic drop hammer which struck a chisel supported by springs at the bottom of the hammer leads. (See Fig. 1.) The hammer was raised by a walking beam. For this particular work a 100-lb. hammer gave the best results. The sides of the 7-ft. strip were marked and only two men were required to operate the machine, one man guiding it and watching the chiseling and the other man operating the engine. The cutting was slow enough to allow the men to pull the machine forward without any trouble.

Breaking Up the Pavement.—In order to break up the pavement after it had been cut the contractor designed an automatic trip hammer which consisted essentially of a 600-lb. hammer on a 14-ft. handle raised by a cable running over a sheave in a steel frame about 16 ft. high. This rig was also mounted on a concrete mixer. (See Fig. 2.) The trip apparatus was attached to the hammer by hand, but the tripping was automatic. The base of the hammer handle contained a large horizontal screw, one end of which was attached to the frame of the mixer. On the other end was a handle. By turning this handle the side swing of the hammer was controlled. Five men operated this machine.

The rate of progress in breaking the pavement depended upon the chisel machine which was operated at night in order to provide enough work for the breaking-up machine.

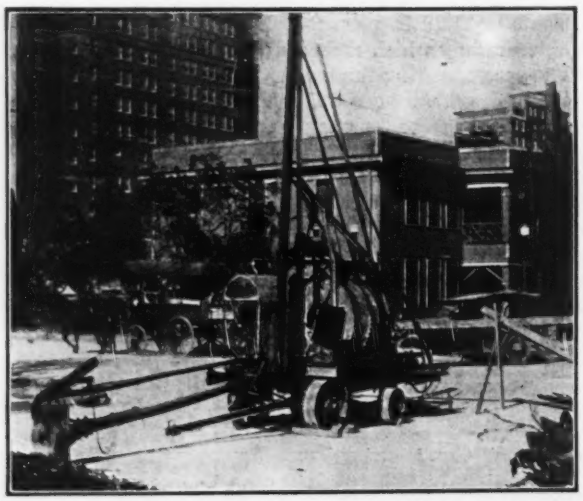


FIG. 2—CONCRETE BROKEN WITH 600-LB. HAMMER

When the wood paving was reached the blocks were cut to the line with a sharp axe. After their removal the hammer easily broke the concrete base. The broken pavement was piled on one side and served as a traffic barricade. Excavated dirt was piled upon the opposite side and used to cure the new concrete pavement laid in the 7-ft. strip.

The work was done under the direct supervision of the writer, with J. B. Upchurch, assistant in charge of paving, associated with him. The contractor was I. H. Roberts, Wichita Falls, Tex.

Drift Bolts Driven Under Water

By D. H. Fleming
Owen Sound, Ontario

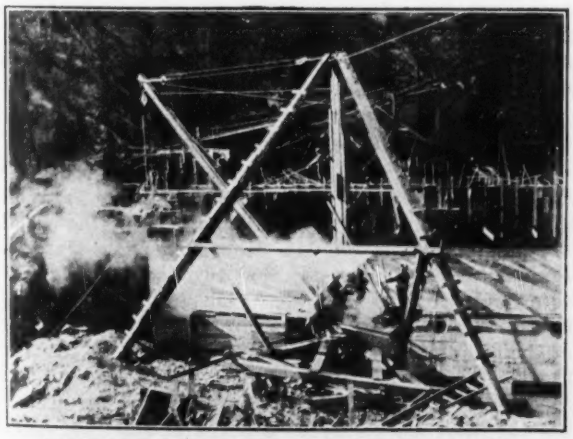
On a dock-construction job being executed in Owen Sound, Ontario, the contractor was required to place 12-in. x 18-in. caps on wood piles one foot below water level. The caps were secured to each pile by a 1¼-in. drift bolt 36 in. long. To do this the caps were bored and the bolt driven close to the water level. Then, to avoid splashing, a piece of 1½-in. iron pipe was slipped over the drift bolt, a follower was inserted and the driving completed without difficulty.

Engine Direct-Connected to Derrick Economizes Operating Space

By R. V. Sass
Superintendent of Construction, U. S. Reclamation Service, Cody, Wyoming

On the Shoshone Project in northern Wyoming the U. S. Reclamation Service has constructed a hydro-electric plant for the development of about 5,400 kw. The power plant is in a canyon so deep and narrow that construction work was handicapped. Some specially-designed plant proved satisfactory in handling the work, and part of that plant was a 5-ton derrick. A guy derrick was unsatisfactory on account of the overhead cableway and concrete distributing chutes. There was insufficient room for a hoist engine in connection with a stiff-leg derrick, so the derrick herein illustrated was employed.

The derrick was of the stiff-leg type operated by a 4 x 7 double-cylinder engine direct-connected to a crab winch with sliding gear. The mast was 30 ft. long and the boom 40 ft. long. The boom line was rigged to one drum and the load line to the other. By shifting the gears either drum could be operated. The tag lines were hand-operated. This derrick was used in the excavation of about 4,000 cu.yd. of material.



POWER-DRIVEN WINCH OPERATES EXCAVATING DERRICK

Automobile Engine Supplies Power to Move Freight on Broad-Gage Road

As a part of its construction system, the Southern California Edison Co. maintains a two-mile length of railroad between Huntington Lake and the head of the 2,100-ft. incline at Cascada, which connects with the San Joaquin and Eastern R.R. system. When any quantity of material is being handled a standard steam locomotive is used for moving it over this two-mile stretch, which is without grade. However, for long periods, and particularly in winter, the freight movement is so light that to maintain the licensed crew necessary to operate the steam locomotive is uneconomical.

FORD ENGINE MOVES STANDARD-GAGE FLAT CARS

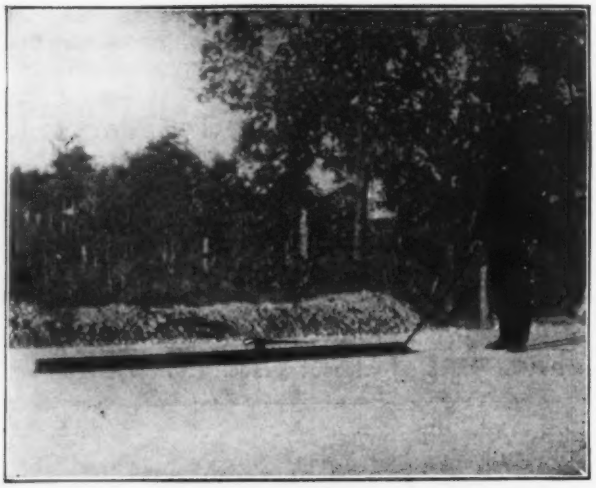
To provide motive power for the movement of light freight, therefore, a Ford automobile engine was mounted on a steel-frame flat-car, as shown in the accompanying illustration. This was done at moderate expense in the company's own shops.

The 30-gal. tank shown herewith is a reserve water supply. It is set high so that water will flow by gravity into the radiator through a short length of hose permanently attached to the tank outlet.

Straight-Edge With Indicator Discloses Rough Spots in Pavement

Exceptional smoothness on new paving on Minnesota highways is attributed by John H. Mullen, deputy commissioner and chief engineer of the State Highway Department, to the use of a straight-edge on asphaltic tops and the use on concrete pavement of what is locally called a transverse strikeboard.

The accompanying view shows H. G. Overholt, a Minnesota inspector, using the straight-edge, which he developed. The device is made from a 2 x 4-in. timber. On the top, at the middle, is a carefully balanced indicator hinged on a fulcrum with one arm four times the length of the other. Attached to the shorter arm is a weighted pin which extends through a perforation in the timber and rests on the pavement surface when in use. The pin has free play. At the opposite end of the indicator is another pin driven into the timber but not



PAVEMENT STRAIGHT-EDGE WITH INDICATOR

attached to the indicator. When the straight-edge rests evenly on a flat surface, the indicator points to the head of the stationary pin. When the straight-edge is pushed over an uneven area, the playing pin raises or drops and the bulge or depression is indicated. When more than ¼ in. variation in the 10-ft. span is shown, the area is rolled again.

On concrete pavement where the straight-edge cannot be used, the department is using a straight board with rounded edges. This discloses any unevenness when drawn over the soft concrete.

Check Method of Staking-Out Skewed Concrete Highway Bridge on Curve

BY OLIVER W. GATCHELL
Assistant Engineer, State Highway Department, Logan, Ohio

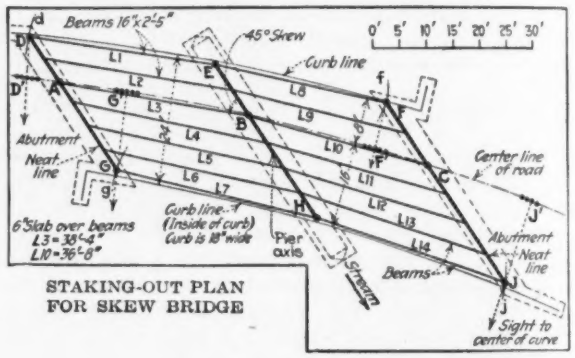
MODERN reinforced-concrete highway bridges built on a skew, on a grade and on a curve with roadway widened and superelevated, with curbs and bridge rail fitting the curve, require special methods in the field for staking-out and control of construction. For example, let us take a bridge of two 40-ft. spans having the pier axis skewed 45 deg. with the center line, and both abutments parallel to the pier axis, the roadway center line being on a 20-deg. curve with a normal 16-ft. roadway widened to 24 ft. and superelevated 18 in., all the beams being non-parallel and of different lengths.

Statement of Problem.—Required so to locate skew abutments and piers with respect to the roadway center line that necessary clearance of curbs from the center line is furnished, with such a span between abutments and pier as to accommodate beams of specified varying lengths.

Treatment.—Locate and permanently flag the center of curve. With instrument at any convenient station on the curve establish *B*, then the groups of points *D'*, *G'*, *F'* and *J'*, which are chain pins stuck in the ground at 1-ft. intervals along the center line near where the radii through *D*, *G*, *F* and *J* will intersect. Set up at *B* and locate the axis of the pier, measuring off points *E* and *H*, using plan dimensions. From *E* and *H* with a steel tape carefully strike the small beam arcs *d*, *f*, *g* and *j*, using the lengths given for the outside beams. The remaining condition for the location of points *D*, *F*, *G* and *K* is that they must be radially distant from the center line an amount equal to the clearance between the center line and the inside of curb, plus the offset, if any, between the inside of the curb and the center of the outside beam at the abutment neat line. For this bridge, at *G* and *J* this offset is zero, and *D* and *F* half the width of the curb, making the radial distance to these pairs of points 16 and 8.75 ft., respectively.

To locate a point, say *D*, cut the beam arc *d* by chaining out the radial distance 8.75 ft. from that pin in group *D'* which lines up when sighting the center of the curve from the beam arc *d*. *F* is located similarly, while for the points *G* and *J* the chainman holding on the pin group lines a flag held at the beam arc on the center of the curve, all lining being by eye.

The sighting process, while involving a small amount of cut and try, is nevertheless accurate and the method checks itself. All the outside beams being of proper length, the lengths of the interior beams will check closely. The spacing of interior beams at abutments is to be adjusted to the field measurements of *DG* and *FJ* in preference to spacing shown on plans. The staking-out method presented confines any small error in the paper plan to throwing the abutments and pier slightly out of parallel, yet it furnishes the exact beam lengths and prescribed roadway width. Note that for spans with decks on a heavier grade than 4 per cent the beam arcs measured on the ground should be shortened the proper amount. The method of staking out given is of general application to a skew bridge with parallel supports on a curve. The method was developed in the field and used by P. W. Ott and the writer.



STAKING-OUT PLAN FOR SKEW BRIDGE

Proposal To Reclaim Alkali Lands with Alum

Soils which do not "take water" because of an excess of gelatinous silicates, chiefly sodium silicate or water glass, have been reclaimed experimentally by the use of aluminum sulphate. C. S. Schofield, in the January *Reclamation Record*, states that two to three tons per acre have shown a very beneficial effect in improving the permeability but have not changed the character of the soil as to its hardness on drying. With ten tons the treated soil becomes soft and easy to work. The commercial alum is considered too expensive for general use but there are numerous deposits of alum and alum-bearing rocks and shales available in the West.

FROM JOB AND OFFICE

Hints That Cut Costs and Time

FROM JOB AND OFFICE

For Contractor and Average Engineer

Plank Housing Protects Steam Shovel During Blasting Operations

IN CONSTRUCTING a road along a steep sidehill, where heavy blasting was required, engineers of the Southern California Edison Co. found that a housing of 2-in. planks in double thickness around the steam shovel used for mucking was a great convenience. During

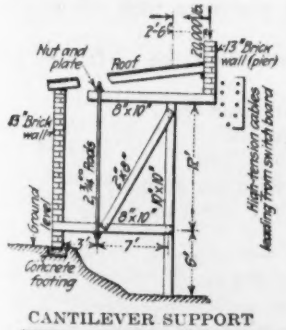
STEAM SHOVEL PROTECTED AGAINST FLYING ROCK

blasting operations, it was not necessary to move the shovel thus protected back as far as otherwise would have been necessary to avoid danger from flying rock fragments. The planking also saved the shovel from damage on several occasions when rocks, loosened by the heavy blasting, came down the steep hillside.

Cantilever Needle Beam Underpins Brick Wall

BY B. S. BASCOME

IN BUILDING a new brick wall in a power house at Warren, Pa., it was necessary to underpin the piers and pilasters while installing new units and equipment. The major part of the work was carried on by supporting the wall with posts and needle beams. In one instance, however, it was found necessary to resort to a cantilever support on account of the proximity to the wall of the high-tension cables leading from the switchboard. Referring to the accompanying sketch: the reaction of the cantilever beam with a load of 20,000 lb. on one end is taken up by two ¾-in. rods which are anchored to an 8-in. x 10-in. timber held in place by the weight of a 13-in. brick wall, a distance of 10 ft. from it. The construction was carried on in connection with the installation of a 3,000-kw. Westinghouse turbine for the Warren Light & Power Co. at Warren, Pa.



CANTILEVER SUPPORT WITH 10-TON LOAD ON ONE END

Ready-Mixed Water Color Kept Usable by Small Shot

BY H. D. HURLEY

Assistant Engineer, Massachusetts Department of Public Works

THERE are many times when it is desirable to use color on a tracing or a blueprint. The ordinary colored inks have not enough body to print well when used on a tracing, or to stand out well when used on a blueprint. Water color, however, will do both, but it is somewhat of a nuisance to prepare it.

The solution is: Obtain a clean ink bottle of the ordinary drafting room type, mix the color to the proper consistency for use in a ruling pen, and place it in the bottle along with ten or a dozen small shot, such as are found in most offices for use in paper weights. When not in use the color will sink to the bottom, but a few shakes will rattle the shot around and stir the color up, and it is ready for use.

Enclosing Pier in Canvas Affords Uninterrupted Winter Work

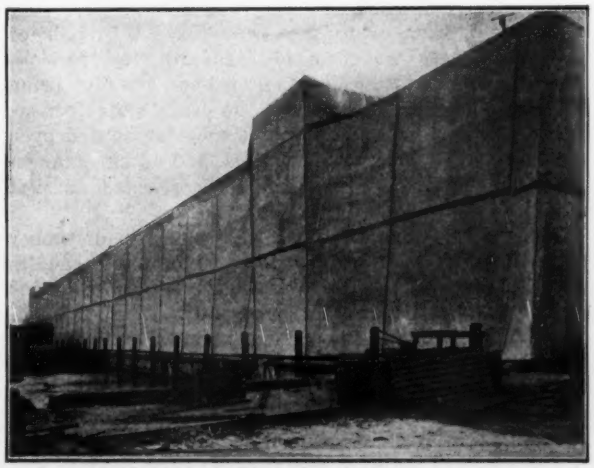
BY A. B. HARDING

Chief Engineer, J. S. Rogers Co., Builders, Philadelphia

AN INTERESTING example of protection against winter weather is seen in the effective method used in the construction of the new Municipal Pier 4 South, Chestnut St., Philadelphia, Pa. The completion by March 30, 1922, is imperative and as the work started Oct. 1, 1921, uninterrupted progress through the winter months was absolutely essential.

The pier is to be a two-story structure, 550 ft. x 75 ft., consisting of skeleton-steel frame of approximately 1,000 tons; concrete floor slabs; brick walls with limestone trimmings, and steel sash. The first deck will be equipped for cargo and passenger handling, and the second deck is to contain administrative offices of the Department of Wharves, Docks & Ferries, City of Philadelphia.

The usual winter protection of heated aggregates for concrete, anti-freeze compound for brick and mortar, and night protection by tarpaulins were found inadequate to meet the weather conditions and the protection illustrated in the photograph herewith was installed. This protection was afforded by 20-oz. waterproof



20-OZ. CANVAS COMPLETELY ENCLOSES PIER

tarpaulins stretched over a frame made of 3 x 6-in. lumber. The entire structure was thus enclosed. The canvas was turned over at the top and fastened to the finished roof, already in place.

The enclosure, being built on the guard log of the pier, left a space of about 4 ft. between the canvas and the outside columns. In this space radiators, set on the ground level, furnished ample heat for placing the brickwork properly. After the walls were up the canvas protection, with radiators between the canvas and the brick walls, formed an envelope of warm air around the entire building, giving absolute protection to all interior work. At the same time the layout is such as not to interfere in any way with the construction, or in the handling of materials, and every day becomes a full working day, regardless of weather.

The heating plant consists of four sections each carrying about 1,250 sq.ft. of radiation, with expansion traps from each radiator dripping to the ground, heat from the condensate being absorbed by the pier fill. The four sections are directly connected to an 80-hp. vertical boiler operating at 5 lb. pressure, centrally located. Each of the sections is valved so that any combination can be used to offset daily wind and weather conditions. The amount of radiation used was based on 1 sq.ft. of radiation per 300 cu.ft. of volume in enclosure. While the system is only designed to give only 30 deg. to 35 deg. temperature difference, 45 deg. was noted early in the morning after a zero night.

The plant consumes between one and two tons of coal per day and is giving entire satisfaction, the work of the building progressing uninterruptedly.

Construction of the pier is being done by the J. S. Rogers Co., Philadelphia.

Design of Overhead Supports for Outdoor Piping Systems

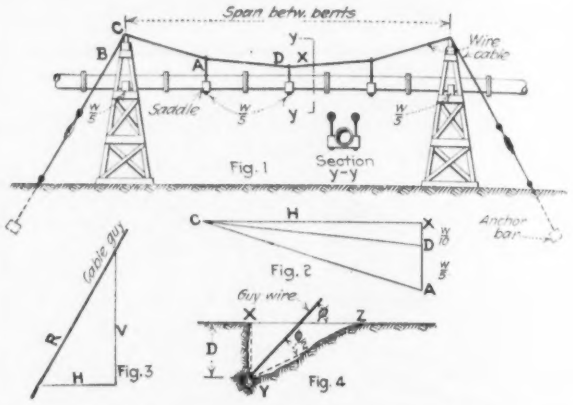
By W. S. Morrison
Assistant Mechanical Engineer, New York Edison Co., New York City

Pipe lines crossing streets or open spaces where the free use of posts is impracticable require some exceptional form of suspension. Where there is considerable load per foot, as in the case of a large gas main lined with brick or other insulating or protective material, a form of support often used is a pair of latticed girders made up of standard steel sections framed between steel columns or towers, the pipe being supported on cradles between the truss thus formed. Steam, air, gas and water mains may be carried by a simple form of wire rope truss. Fig. 1 is an arrangement in common use and has been selected as best suited to the purposes of this article.

The end bents or towers here shown may be of timber or steel, the pipe being supported at intervals by saddles attached to hangers, the cables being carried over the end supports and into the ground and attached to deadmen. Where the load carried is considerable, care should be taken that the saddle be liberally proportioned to the end that the load transferred to or from the pipe is distributed over the pipe. If necessary, the pipe should be reinforced at such points.

The stress in the wire rope depends upon the load and the sag permitted in it. Taking the forces about apex *C*, the horizontal component of *BC* must equal the horizontal component of *CA*. Similarly, the horizontal component of the forces acting at point *A* are equal.

In Fig. 2, $XD = W/10$ and $DA = W/5$ in which W = the total load between the end supports. H is the horizontal component of the combined forces due to the



WIRE ROPE TRUSS IN COMMON USE—FORCE DIAGRAMS

loads at *DA* and *AC*, acting in the wire rope on each side of apex *C*. In Fig. 2, *CA* and *CD* give the magnitudes and directions of the rope stresses and the sag of the rope may be found by drawing these rays in Fig. 1, or the rays may be first drawn in Fig. 1 and transferred to the stress diagram, Fig. 2.

In Fig. 3 R is the pull on the guy rope necessary to resist the effect of the load, and V is the vertical component of the force R. The force V is transferred to the end support along with its proportion of the weight of the pipe.

The following formula pertaining to the holding strength of guy anchors of the type shown in Fig. 1 has been developed as the result of observations in practice and is recommended for use where a structure is to be guyed against a pull. Fig. 4 shows diagramatically the way in which a guy anchor would be pulled out of the ground. The earth wedge resisting the pull is *XYZ* and the slope *YZ* has been found to divide approximately the angle ϕ of the guy wire with the ground by two.

D = depth of anchor bar below the surface of the ground, feet;
W = weight of earth per cubic foot;
P = pull on guy wire, pounds;
l = length of anchor bar, feet;
ϕ = angle of guy wire with the ground;
f = coefficient of friction, earth to earth;

$$D = \sqrt{\frac{P\,2\tan\frac{\phi}{2}}{Wl\left(f\cos\frac{\phi}{2}+\sin\frac{\phi}{2}\right)\cos\frac{\phi}{2}}}$$

The accompanying diagram, Fig. 5, has been prepared by the writer for ready reference and is calculated from the above formula for an anchor bar one foot long,

FROM JOB AND OFFICE

Hints That Cut Costs and Time

FROM JOB AND OFFICE

For Contractor and Average Engineer

taking the average of 100 lb. per cubic foot for earth with the different friction coefficients for earth on earth as given in handbooks. For example, the pull on a guy wire attached to an anchor bar is 15,000 lb. with an anchor 10 ft. long, using a factor of safety of 5, the pull

TABLE I—STANDARD STEEL GALVANIZED STRAND WIRE ROPE
7 WIRES TO THE STRAND

Diameter	Approx. Weight per ft. lb.	Approx. Strength in lb.
1	0.80	14,000
7/8	0.65	11,000
3/4	0.51	8,500
5/8	0.415	6,500
9/16	0.295	5,000
1/2	0.210	3,800
7/16	0.125	2,300
3/8	0.095	1,800
5/16	0.075	1,400
1/4	0.055	900
7/32	0.040	700
3/16	0.032	500

per foot will be 7,500 lb. Assuming that the earth is composed of dry sand, clay and mixed earth and assuming an angle of 45 deg. between the guy cable and the ground, from the diagram, dropping vertically from the top scale indicating the angle to the diagonal line indicating the coefficient of friction, then horizontally to the line indicating the pull per foot of anchor and from there to the bottom scale, read $D = 8.95$ ft.

Example, referring to Fig. 1: A 12-in. full-weight pipe containing steam is to be carried over a total span of 60 ft. between bents, the pipe lengths will come in 15-ft. sections between flanges and the pipe is to be continuous over the two end supports at a height of 18 ft. above the ground. Required the size of the wire rope necessary to carry the load, the height of point *C* above the ground and the required depth of the guy anchor below the ground level to resist the pull on the guy wire due to the load, assuming dry clay, sand and

TABLE II—SPECIAL GRADE EXTRA GALVANIZED STEEL STRAND WIRE ROPE

Diameter	No. of wires in strand	Approx. Weight per lb.	Approx. Strength—Pounds S. M. Strand	Crucible Steel	Plow Steel
1¼	61	4.75	110,000	183,000	242,000
1⅛	61	3.95	91,000	152,000	200,000
1⅛	37	3.30	76,000	127,000	170,000
1	37	2.62	65,000	108,000	144,000
⅞	37	2.25	51,000	87,500	120,000
¾	19	1.70	32,000	64,000	90,000
⅝	19	1.25	28,400	47,500	70,000
½	19	0.81	20,000	33,000	47,000

mixed earth with a coefficient of friction, earth to earth, of 0.5.

The weight of a 12-in. pipe per foot including flanges is 63.2 lb. The total weight of the pipe between bents will be 63.2 × 60 equals 3,792 lb. If we divide the total span into four sections of 15 ft. each, the load at each support will be 758.4 lb. Drawing the ray *DA* at an angle of 8 deg. from the horizontal and the ray *AC* at an angle of 16 deg. with point *D* a height of 2 ft. from the center of the pipe, the apex *C* will then be $(15 \times \tan 16°) + (15 \times \tan 8°) + 2 + 18 = 26$ ft. 4⅜ in. from the ground level. The horizontal component of the load in the rope truss will then be

$$H = \frac{\frac{W}{10} + \frac{W}{5}}{\tan 16°} = \frac{379.2 + 758.4}{0.2867} = 3968 \text{ lb.}$$

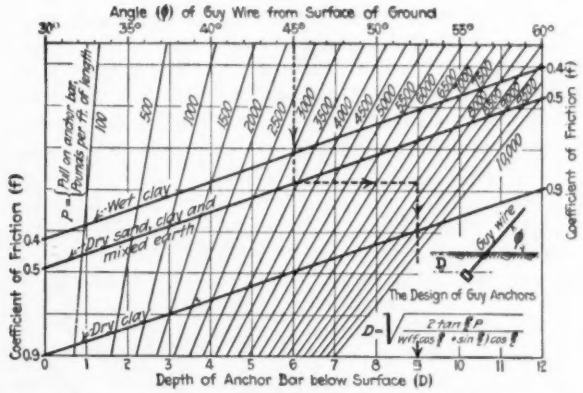
neglecting the weight of the rope itself as its weight will be small compared with the load.

If we use 45 deg. as the angle of the wire rope guy with the ground level, then the pull on the guy wire will be

$$R = \frac{H}{\text{Sin } 45°} = \frac{3,968}{0.707} = 5,612 \text{ lb.}$$

But as there are two ropes carrying the total load, the pull on one rope will be 2,806 lb. Applying a factor of safety 5, we should select a rope capable of resisting a pull of 14,030 lb. From Table I a ⅞-in. seven-strand standard steel rope will answer for this case.

The total pull on the anchor bar will be equal to the total resultant in the guy wire and this pull is 5,612 lb.



DETERMINING ANCHOR DEPTH FROM KNOWN FACTORS

With an anchor bar 10 ft. long using a factor of safety of 5 the pull per foot will be 2,806 lb., say 3,000 lb.

Referring to the diagram, Fig. 5, the required depth for the anchor below the ground level is 5.7 ft. for an angle of 45 deg. and a coefficient of friction, earth to earth, of 0.5.

The total load at each end support will equal the vertical component (*R*) of the tension in the guy wire, plus the load *W*/5, the pipe being continuous and assumed to be carried by hangers or posts a disfance from each end equal to the short spans inside the bents. In this case, then the load at each bent is,

$V + W/5 = 3,968 + 758.4 = 4.726$ lb., or 2.39 tons.

If, in the above example, the pipe were filled with water, the distance between supports remaining the same, the total weight of the pipe between the end supports would be 112 × 60 or 6,720 lb., and by the same method of calculation *H* would equal 7,031.74 lb. and *R*, for each rope, would equal 4,972.94 lb. Applying a factor of safety of 5, as before, the rope will be required to develop 24,864 lb. An inspection of Table II will show that a Sieman-Martin ¾-in., nineteen-strand rope with an approximate strength of 28,400 lb. comes the nearest to meeting the requirements. With an anchor bar 10 ft. long the pull per foot, applying a factor of safety of 5, will be 4,973 lb., say 5,000 lb. Inspection of the diagram gives 7.3 ft. as the required depth of the anchor below the surface of the ground to meet this condition.

The vertical load on the end support will, in this case, be

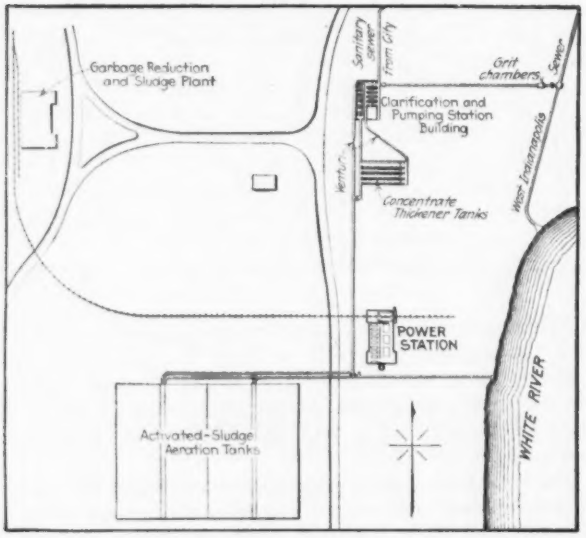
$V + W/5 = 7,031.74 + 1,344$
$= 8,375.74$ lb. $= 4.18$ tons.

Clarification and Activation for Indianapolis Sewage

Three Revolving Cylindrical Screens, Removing 30 Per Cent of Solids, Considered Sufficient for Six Months—Activated-Sludge Process Added for Remainder of Year

By C. H. Hurd
Consulting Engineer, Board of Sanitary Commissioners, Indianapolis, Ind.

CLARIFICATION by revolving barrel screens and tank thickeners is all the treatment it is proposed to give the sewage of Indianapolis, Ind., for about half the time. Five-year tests indicate that there is enough dissolved oxygen available in White River to meet the oxygen demand for six months of each year. For the remaining period of the year, May to October, additional treatment by the activated-sludge process will be provided. Construction of the work is well under way and the clarification portion of the works will be ready for operation within a few months. The sewage will have to be pumped only during the time when the activated-sludge process is used. In the following article



PLAN OF INDIANAPOLIS SEWAGE- AND GARBAGE-WORKS
It is expected that sludge from the new sewage-works will go to the garbage reduction plant.

there are discussed the studies made during the past five years, experiments with screens and activated sludge, deductions drawn from these experiments and the changed conditions which led to the choice of the designs adopted.

Not until the city reached a population of 200,000, which was coincident with the development of the packing house industry, did the discharge of the sewage into White River become a gross pollution and a nuisance of considerable magnitude. The present population is 350,000 making the city the largest on an unnavigable stream in the United States, but from the standpoint of sewage treatment—that is, total organic solids contained in the sewage—the sewage discharge is equivalent to that of a city of at least 500,000 people.

White River, which furnishes the city with water, has a drainage area above the city of 1,800 sq.mi. The characteristic of the stream that affects sewage treatment is its low flow during the hot months of summer and relatively high flows during the balance of the year, particularly during the late autumn and early spring. Monthly average gagings have been recorded during dry periods of less than 175 sec.-ft., while the maximum frequently reaches several thousand.

For the most part, Indianapolis has a combined system of sewers. The dry-weather flow is approximately 50 m.g.d. With the large quantities of organic solids pouring into the river, and the low summer flow, it is readily seen that the digestive power of the river is exceeded. During such periods the oxygen is entirely exhausted for several miles below the city. Fish are destroyed and, on account of the escaping odors, living conditions in the immediate vicinity of the river are almost unbearable.

Prompted by a report to the State Board of Health setting out the conditions in this river and by the appeal of farmers and others living along the stream, the legislature in 1917 enacted a law creating sanitary districts in cities of the first class, applying only to Indianapolis. A sanitary commission was provided with power to construct a sewage disposal plant and to carry on other sanitary work within the sanitary district. This district consists of the city of Indianapolis and the town of Woodruff Place, a municipal corporation located within the city's boundaries.

The Board of Sanitary Commissioners was appointed according to statute and organized during the month of May, 1917. During the following summer considerable investigative work was carried on under the direction of the board, consisting of flow measurements, determinations of the character and strength of sewage and detailed studies of the various trade wastes of industrial plants which were connected either with the sewer system or directly with the river. Much of this information was used as the basis of a report on sewage treatment made by George W. Fuller in September, 1917 (see *Engineering News-Record* Nov. 22, 1917, p. 972). Very little was accomplished during the year 1918 except to continue the collection of data which was started the previous year.

In April, 1919, the sanitary board entered into a contract with the writer, its present consulting engineer, to design and supervise the construction of the complete sewage disposal plant. At this time results of former investigations were analyzed and definite policies determined as to type of plant and general construction problems.

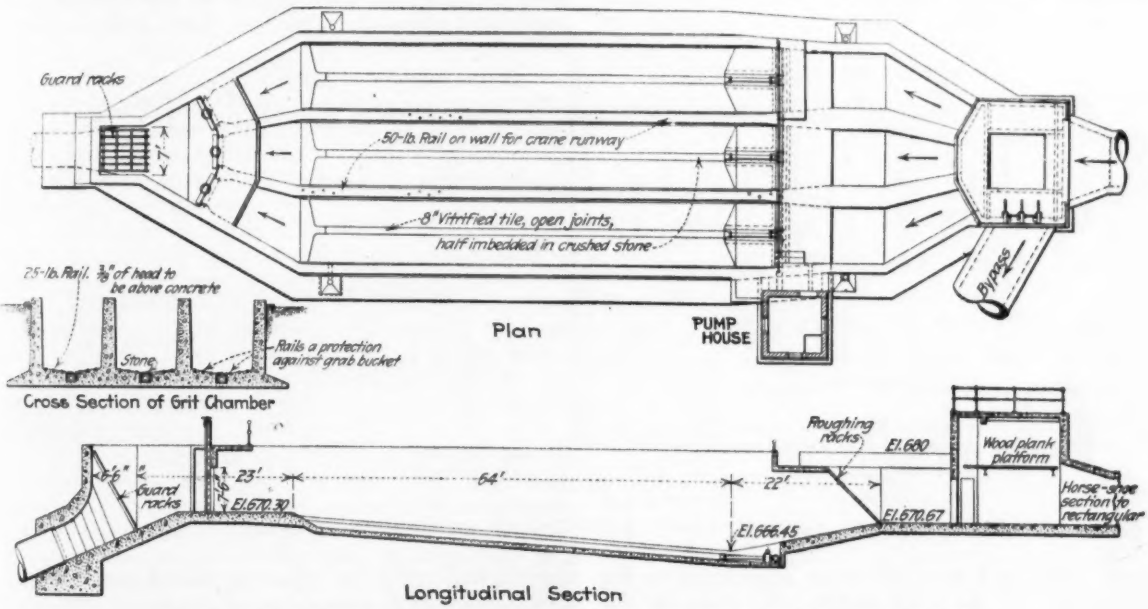
Upon instruction from the sanitary board, Mr. Fuller, in his report (1917) was guided in his recommendations by the provisions of the act of the legislature which limited the fund available for annual operation and maintenance expense but provided a more liberal amount for plant construction costs. In 1919 and at the beginning of the present work the board concluded it would build a plant of a type which would give the highest degree of purification and at the same time would give the highest ultimate economy, considering both operating expenses and construction costs. In conformity to this latter view, the legislature in 1920 amended the act, increasing the maintenance fund, thereby giving the

commission greater power and latitude in the selection of the character of the plant to be constructed. Of the conditions and characteristics necessarily considered in connection with the selection of the type of plant, the dilution factor, the seasonal variation of stream flow and organic matter carried by the sewage are pre-eminent. The degree of purification is also important, as well as the relative freshness of the sewage in its relation to the removal of organic solids. Estimates of construction costs of plants of various types, including the cost of power and general operating expense, were obviously necessary before final analysis could be made and a decision reached as to plant construction.

In connection with the studies as outlined, and by reference to the accompanying table showing oxygen available and required for various conditions throughout the average year, it is quite apparent that with the velocity of flow and the character of the stream bed. White River below Indianapolis is for the most part shallow and has an average fall of approximately 3½ ft. per mile. The stream bed contains many boulders and riffles and, as a whole, conditions are perhaps more favorable for re-aeration and replacement of oxygen than for the average river in the Middle West.

The standard of purification or completeness of disposal is of course dependent upon the extent of the nuisance created compared with the total cost of corrective treatment. The nuisance created below Indianapolis with the full discharge of untreated sewage flowing into the river during dry weather flow is such both in extent and character that the demand for treatment is unquestionable.

The river water is not used as a source of public water supply within a distance of 175 miles below



PLAN AND SECTIONS OF GRIT CHAMBER FOR INDIANAPOLIS SEWAGE-WORKS

coarser settling and floating solids removed, at least under present conditions, further treatment might not be necessary except for about six or seven months during the year. If advantage could be taken of this fact in the selection of the design and type of plant, considerable saving could be effected in the total cost of sewage treatment.

The rapidity with which dissolved oxygen becomes depleted in flowing streams depends upon the decomposable organic matter present, and its replenishment is directly affected by the depth of the stream, the Indianapolis; hence during periods of high flow advantage may profitably be taken of the dilution factor, thus effecting a very considerable saving in treatment cost.

By analysis the problem of sewage treatment resolves itself into two parts. During the summer or for approximately six months in the year, complete disposal of organic solids must be made; during the balance of the year, or through the period of greater dilution, only such treatment may be necessary as will remove the coarser organic solids, leaving an effluent within the

AVAILABLE AND REQUIRED OXYGEN IN WHITE RIVER

	Oxygen Available			Oxygen Demand		River Flow		
	Parts per Million	Lb. per M.G.	Lb. Per Day	Lb. Per Day	Parts per Million	M.G.D.	Sec.-Ft.	Sec.-Ft. per 1,000 Pop.
January	12.6	104.8	57,900	.....	...	579	900	4.5
February	12.3	102.3	66,600	.....	...	651	1,000	5.0
March	11.9	99.2	98,700	56,000	150	996	1,540	7.8
April	10.2	85.2	68,100	59,000	158	798	1,230	6.2
May	8.5	70.8	25,800	61,300	164	365	570	2.9
June	7.3	60.8	18,600	69,800	187	305	470	2.4
July	6.9	57.5	13,800	66,500	178	242	380	1.9
August	7.4	61.7	14,400	60,200	161	234	360	1.8
September	7.9	65.8	14,410	52,300	140	219	340	1.7
October	9.5	79.2	17,800	50,800	136	225	350	1.8
November	11.0	91.7	53,200	53,000	142	579	900	4.5
December	12.5	104.1	60,600	52,200	140	581	910	4.6

Oxygen dissolved figures are 5-year averages of daily determinations. Oxygen demand is calculated on the basis of 45 m.g.d. flow of sewage. Flow in White River is obtained by correlating daily gage readings for 8 years, averaged by months, with three-months' readings at a point of measured cross-section.

range of the digestive power of the river; or, in other words, with the oxygen demand less than the amount of the dissolved oxygen available. From the viewpoint of design and construction a plant to perform the above function must be a combination of a clarifying and complete treatment system.

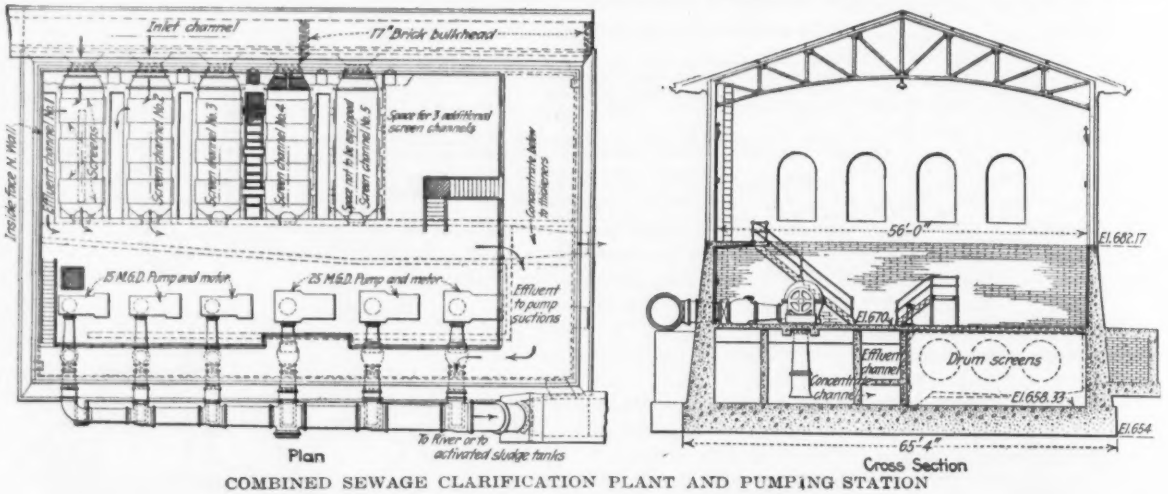
The removal of suspended solids either by screens or rapid sedimentation is dependent to a very large measure upon the relative freshness of the sewage. Indianapolis sewage, as has been stated, is not only comparatively fresh in character but is high in organic nitrogen. Analysis by the Kjeldahl method shows that of the total suspended matter 3 per cent is organic nitrogen. In the coarser solids, removed by fine screens and rapid sedimentation at times due to the inflow of packing house wastes, the nitrogen content is much higher than 3 per cent.

Based on the general assumption that the most practical means of sewage disposal is the separation of organic solids, and with particular application to the higher stages of the river, considerable research and investigative work was done during the years of 1919 and 1920 to determine the most economical method of making such removal. Studies were made of existing screen plants, including those at Rochester, N. Y., and the demonstration plant at Milwaukee, Wis., as well as the plain sedimentation experiments, in which valuable data were obtained, at Syracuse, N. Y. As a result of this investigation, a demonstration plant was installed using a combination of revolving screens and sedimentation units. The results of the tests at this plant gave such promise that the board adopted this system of clarification to be used in the permanent construction.

In selecting the type of plant best adapted to Indianapolis conditions, consideration must necessarily be given to the operation of the whole or final plant. It is not sufficient to determine the cost of producing an effluent of certain fixed standards but the cost of treating and disposing of sludge must also be estimated. In the type of clarification which has been adopted, it has been shown at the demonstration plant that a removal of 30 per cent of suspended solids will give an effluent which would be satisfactory through the period of greater dilution in the river. It has also been shown that the sludge obtained by the removal of the 30 per cent of coarser solids is of such a nature and character that it is easily drained to 85 per cent moisture, after which it may be readily handled and dried.

During the year of 1921 a demonstration activated-sludge plant was constructed and operated in connection with the screen and rapid sedimentation plant to determine the effectiveness of this method of treatment on Indianapolis sewage. Three complete units were installed, with aeration tanks 12 ft. in diameter and 15 ft. high and settling tanks about one-half the capacity of the aerators. Air was supplied through filtros tile in the usual manner, provision being made for filtering and scrubbing the air to eliminate dust or particles of oil which would tend to clog the filtros plates.

At this plant both screened and unscreened sewage is available. In the first run of ten weeks two units were operated under identical conditions to show comparative results with and without screening. The third unit was operated to demonstrate if possible any advantage of mechanical agitation. This run, fairly typical of sub-



COMBINED SEWAGE CLARIFICATION PLANT AND PUMPING STATION

sequent tests, gave the following general results: Tank 1 with unscreened sewage gave an average of suspended solids in the effluent, 25 p.p.m.; oxygen consumed, 30 p.p.m.; stability, 3 days; cubic feet of air per gallon, 1.35; rate per acre, m.g.d., 22; sludge, pounds per m.g., 1,656. Tank 2 with screened sewage gave suspended solids in the effluent, 19 p.p.m.; oxygen consumed, 26 p.p.m.; stability, 7 days; cubic feet of air per gallon, 1.30; rate per acre, m.g.d., 21.5; sludge, pounds per m.g., 1,152.

The above statement does not show the advantage of the uniformity of operation of tank 2 nor the difficulties which were experienced in the handling of undigested solids in tank 1. Tank 3, which was operated as a combined unit using both air and mechanical stirring, did not give a satisfactory stability or effluent and was abandoned at the end of this run.

Encouraged by the results of a small baffled tank used as a circulating unit with filtros tile arranged to give rapid circulation by the air-lifting effect, tanks 2 and 3 have been equipped in this manner, and No. 1 is being operated in the standard form as a control unit. The filtros areas in Nos. 2 and 3 are 10 per cent and 12 per cent respectively. These tanks are similar in construction except that No. 3 has an additional baffle. Tank 1 has 25 per cent filtros tile area. The three tanks are operated on screened sewage.

Delay was experienced in placing the modified plant in operation due to an extremely high river during November and the first half of December. All three units are now "tuned up" and producing an effluent of high stability. They are operating with considerably less than 1 cu.ft. of air per gallon of sewage. Tanks 2 and 3 show a perceptable saving in the use of air over tank 1 and also greater capacity with the same effluent standard.

It is appreciated that the experimental work on activated sludge at this plant has covered a relatively short period compared with the work at Milwaukee and many places in England, but with the developments in the last two years both in this country and abroad and with the low cost of power in the vicinity of Indianapolis this method offers many attractive features.

From data available and based on very conservative estimates the cost of a complete activated-sludge plant will approximate nearly $1,000,000 less than a complete sprinkling-filter installation. Under the conditions imposed, after careful analysis and deliberation, taking into account the probable period of operation and upon the recommendation of its engineer, the Board of Sanitary Commissioners authorized the construction of the activated-sludge plant with the cost not to exceed $3,000,000.

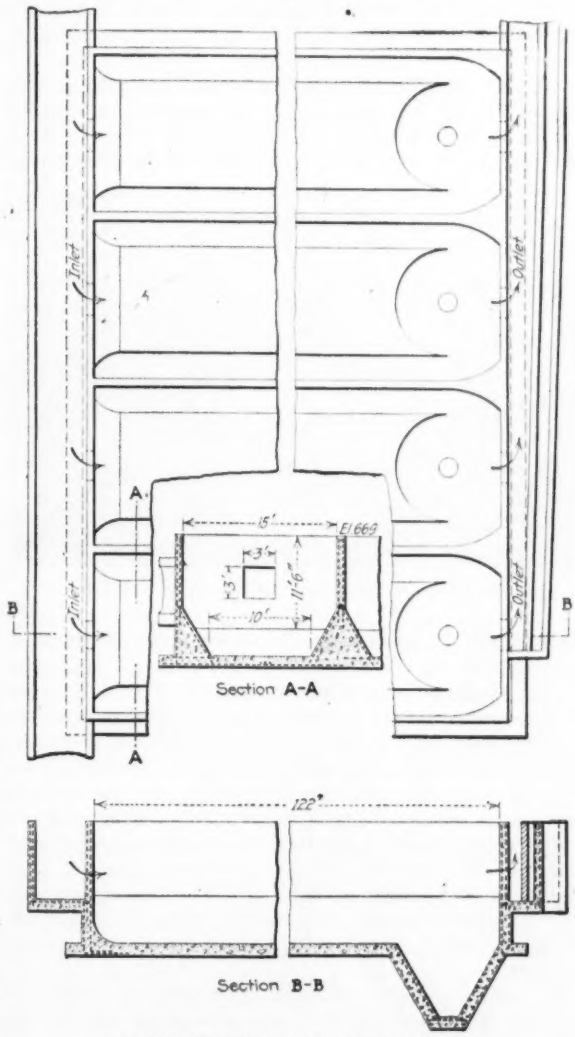
The site selected for the construction of the disposal plant is a 225-acre tract located on the opposite side of the river and two miles below the outfall of the main or east side intercepter. In order to conduct the sanitary sewage to the plant site it is necessary to cross the river with an inverted siphon 1,000 ft. long. To prevent deposits in the siphon it was deemed best to locate grit chambers on the east bank of the river immediately in front of the siphon.

The grit chambers containing the coarse bar screens are constructed with three channels, each 10 ft. wide with walls 10 ft. high. Each channel is provided with independent gates to be used in dewatering and stop planks for regulation of the flow. A controlling gate is also installed at the head of the chambers. It operates as a submerged weir and serves as an overflow for storm water and for rate control. Velocity through the chambers may be regulated from 7 to 1 ft. per sec. Since the siphon and two miles of conduit are between the chambers and the plant, it was possible to construct the channels to give practically constant velocity for any predetermined sedimentation period.

Sixty-inch cast-iron pipe is used in the construction of the siphon, which is laid from 7 to 12 ft. below the bed of the stream. The crossing is now (Jan. 15) about 60 per cent completed and is proceeding in open cofferdam with the use of 40-ft. steel sheet piling. Each 12-ft. length of pipe is supported on four 20-ft. piles and further protected by two guard piles driven on the downstream side. Progress is made at the rate of from 100 to 150 ft. per month.

From the end of the 60-in. siphon the sewage will flow through 10,000 ft. of 78-in. reinforced-concrete conduit, which has been completed. This conduit continues in almost a straight line, is built on a grade of 0.0008 and has a capacity of 108 m.g.d. At the point where this conduit delivers sewage into the pump-well it is united with the connecting conduit from the west side intercepter, which is provided with grit chambers and coarse screens of a size corresponding to the flow for that system.

The original design for the pumping station contemplated pumping the sanitary sewage throughout the entire year. The present plant construction is such that it is unnecessary to operate the pumps in connection with sewage clarification, and pumping is only required during the period of complete treatment or during extreme flood conditions. As shown in the plan, the pumping station includes the revolving fine screens which are placed ahead of the pumps. The pumping equipment consists of three 25-m.g.d. electrically-operated centrifugal units and three 15-m.g.d units of the same type and design. The capacity provided is sufficient to take the entire sanitary flow from both the East and West Side intercepters.



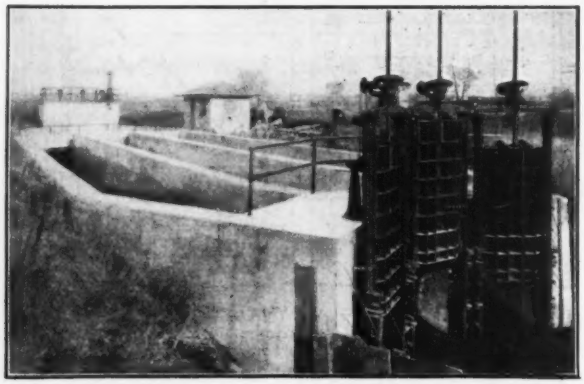
CONCENTRATE-THICKENER TANKS

More than ordinary care has been exercised in the design of plant buildings. For the most part, a Spanish type of architecture has been used. The color effect is gray buff brick and terra cotta trim with green glazed tile roof. All buildings are fireproof and the general arrangement is consistent with the use of the additional acreage, which will be a part of the city park and boulevard system.

The pumping station and clarification building is 104 ft. long, 60 ft. wide and 56 ft. from the bottom of the pump pit to the inside of the roof. The pumps and fine

screens are located 12 ft. below the ground level. An electric traveling crane is installed to handle poth pumps and screens and may be operated from the lower level or from a gallery provided at the ground level. Fresh water pumps, air compressors and priming equipment are installed in the sub-basement; all are electrically driven and connected with a conveniently located switchboard.

The clarification plant for the partial removal of suspended solids comprises 12 revolving drum screens arranged with three in each channel. Beyond the third screen the flow, which has not passed into them,



GRIT CHAMBERS AND REGULATING GATES

proceeds to the concentrate-thickener tanks constructed just outside of the pumping station building. The design of the screens is practically the same as is used in the paper manufacturing industry. The frames are constructed entirely of brass and bronze, 6 ft. in diameter and 8 ft. long, and are arranged to filter from outside, delivering the effluent through openings at the end. In a measure the screens are self-cleansing as part of the effluent in passing through the downstream side of the screens removes adhered solids. The cleansing is further assisted by the rotation of the screen element through this clarified zone. Thirty-mesh phosphor-bronze wire cloth is used as the screening medium.

In order that the screens may give a maximum removal it is essential that the process be carried on without the breaking up of the solid particles. For this reason the heavy concentrated sewage, containing all the retained solids, is conducted by gravity to the concentrate thickeners from which the heavy sludge is continuously removed by mechanical means.

The concentrate-thickener tanks are four in number, 15 ft. wide at the top and approximately 120 ft. long. The tanks will be equipped with slowly moving flights which will move with the current and at the same rate with a maximum speed of 5 ft. per minute.

Venturi meters are being installed both in the line to the concentrate thickeners and in the main effluent conduits. The clarified effluent may be diverted to the river or pumped to the aeration tanks for final treatment. Venturi recorders are placed in the pumping station building and alongside the switchboard for convenience in operation.

For the activated-sludge plant, aeration tanks are being designed, 120 ft. long, 15 ft. deep and of variable width depending upon the baffling to be used. Settling tanks for the sludge produced will be of the same general dimensions as the aeration tanks and will be operated in a manner similar to the concentrate thickeners. Operating galleries are to be constructed over the ends of the tiers of tanks, housing piping, valves and control equipment.

Air for this system and electric power for pumping and for the various mechanical devices will be furnished from the main power plant, in which will be installed four 400-hp. water-tube boilers with chain-grate stokers and complete coal-and-ash handling equipment, four 9,000-cu.-ft. steam turbine blowers, two 750-kw. steam turbine generators and all necessary condensers and auxiliaries.

The building for the power plant will be 140 ft. long, 70 ft. wide and 55 ft. high from basement to roof. Besides housing the power-plant units it will contain storage for 1,000 tons of coal and means for crushing, conveying and unloading under cover.

The administration and laboratory building, now under construction, will contain two full stories and basement. The first floor will be used for superintendents, accountants, store room, time keepers and office; the second floor for the chemical and bacterial laboratory. Space in the basement is provided for experimental and demonstration work. This building is 40 x 65 ft. in floor plan and is constructed in style and type similar to the pumping-station building.

Experiments are now being made at the demonstration plant to determine the most practicable method of sludge disposal. Work is being done with the Maclachlan gas process and filtro pressing. A screw press of the Anderson type will be installed for further dewatering crude sludge. It is expected that the problem of disposing of the activated sludge produced will be considerably minimized by the comparatively short periods when this part of the plant will be operated and by the removal of a large percentage of suspended solids before aeration. At this same site there will be works for garbage reduction which also come under the sanitary board.

Contracts for the grit chambers, river siphon, sanitary conduits and collecting system were awarded in July, 1919, and for the pumping and clarification plant in August, 1921. This part of the plant will be completed and placed in operation during the early summer of 1922. Plans are being prepared for the power plant and activated-sludge system. It is expected that this last division of the works will be in operation within one year from the date of the contract.

Third Water-Supply Conduit for Syracuse

A third water-supply conduit from Skaneateles Lake is being built by the city of Syracuse. For the present only six miles will be constructed. Contract for this portion has been let and it is hoped to have it in operation by Aug. 1. This section will merely compensate for friction loss in the first two conduits, and by adding 3 m.g.d. to the capacity of the two existing conduits will give a total capacity of about 28 m.g.d. until the third conduit is built for the whole distance. All three conduits are of bell and spigot cast-iron pipe. The first conduit was 36 in. in diameter. The second one was 42 in. in diameter for about 1½ miles, and 30 in. for the rest of the way. The 6 miles of the third conduit now being built, at the Skaneateles Lake end, is 36 in. in diameter. T. H. Mather is city engineer of Syracuse.

Railway Curves: Superelevation and Maintenance—II

Editorial Review Shows Variations in Practice and Opinion—Influence of Modern Locomotives —Relations of Curvature to Gage and Grades—Checking and Marking

By E. E. R. Tratman
Associate Editor, *Engineering News-Record*

ASSUMING a satisfactory elevation to have been selected and properly applied to a curve, it soon becomes subject to modification under the influence of traffic and the settlement of ballast and roadbed. Both the alignment and superelevation may in time become more or less out of true, in spite of occasional checking and even if the curve is monumented or marked by line and elevation stakes. Maintenance of line and elevation on curves is left mainly to the roadmasters or supervisors, who examine the curves occasionally. In some cases they are provided with cords of certain length and are supposed to check curves frequently as to their uniformity by means of ordinate measurements. This is held to be sufficiently accurate under ordinary conditions, uniformity in line and superelevation being one of the main requisites for easy riding curves. All roads require observations of curves to be made by roadmasters or engineers traveling over their divisions on trains and noting points where the trains do not ride smoothly. In most cases, it is the aim to keep the elevation as low as will give an easy riding track for passenger trains.

The first installment of this article, in the issue of March 16, 1922, discussed the principles underlying the use of superelevation, and reviewed the practice of more than twenty railroads as to formulas, ranges of curvature and speed, rates of increase in elevation, amounts of maximum elevation, spiralling and run-out. This concluding installment takes up the checking and maintenance of existing curves.

Rail wear is usually a factor in determining the superelevation in maintenance work. But increased rail wear may be a normal result of larger and heavier engines (as noted later), so that excessive elevation may be introduced if this traffic condition is not taken into account. A tendency to excessive elevation in maintenance work is noted particularly by one railroad. Thus, as soon as the elevation is put up so as to make an easy riding curve it is found that enginemen will increase speed, which in turn leads to further increase in elevation. On some portions of the line this condition made it necessary to restrict the elevation to an arbitrary limit of 3 or 4 in.

Engineering inspection and checking of curves is carried out to some extent by the engineering department, but in general this applies to individual curves where excessive rail wear or rough riding of trains indicates that attention is needed. One maintenance engineer expresses the opinion that the engineering department should specify the amount of superelevation, should mark this elevation at the curve and should check the curve at intervals of six months. A longer period might suffice where curves are adequately marked, as noted later, but it does not appear that any road follows such a systematic checking.

Survey and resetting of curves by engineers is done usually under two conditions only: (1) when improvement work is being carried out, such as rail renewal, reballasting or surfacing; (2) when a curve rides badly and the track forces seem unable to adjust it properly, so that the superintendent, roadmaster or local maintenance engineer calls for relining and staking of the curve.

In view of the development in weight and wheelbase of locomotives an inquiry was made as to whether present rules and practice in curve superelevation are proving satisfactory with modern equipment. Most of the replies were in the affirmative but were evidently rather perfunctory. Two exceptions throw a different light on the matter and suggest that other cases of unsatisfactory experience may be found on individual divisions or portions of railway systems. One of these unfavorable replies was simply to the effect that the rules give superelevation which is excessive for certain new engines, so that it has been necessary to reduce the elevation materially in order to avoid derailments.

Another reply is more specific and points strongly to the locomotive as a present factor in curve elevation. On a division having rather crooked alignment and handling a considerable number of heavy freight trains, new engines of the 2-8-2 type, with a wheelbase of 21 to 22½ ft. gave considerable trouble on curves of 6 deg. owing to a tendency of the leading driving wheel to lift from the rail. The curves had been elevated for passenger trains, up to a maximum of 7 in. The new freight engines were supposed to traverse curves of 8 deg. with gage widened ¼ in., but in order to operate them it was found necessary to reduce the elevation about 50 per cent on curves of 4 to 8 deg. and to limit the maximum elevation to 5 in. As freight traffic was the more important, "slow" orders were issued to reduce passenger train speeds at the troublesome points from 50 m.p.h. to 30 or even 20 m.p.h. These engines would not curve freely enough to take No. 8 turnouts at terminals, where the curve was about 9½ deg., as the driving wheels would spread the guard rails or the trucks would get on the wrong side of the frogs.

It is almost universal practice to keep the low or inner rail at grade, and to raise the outer rail to full elevation. An earlier but limited practice of lowering the inner rail by half the amount and raising the outer rail equally, thus keeping the center line of track at grade, appears to be obsolete. Two exceptions are noted to meet special conditions. On double track, one railroad raises the outer rail of the outer track and depresses the inner rail of the inner track, in order to maintain the same level for the rails adjacent to the center line of roadbed. In another case, junction curves leading from the outside of main line curves, have the inner rail dropped in order to obtain the effect of superelevation on the turnout.

At main line junction curves, superelevation of the

outer rail through the turnout or beginning of curve is impracticable, owing to the frog intersection of the curved lead rail and main line tangent. It is usual practice, therefore, to issue slow orders or speed restriction limits for such points and to use a turnout curve which will be satisfactory for these speeds. Two roads report special arrangements at such curves; one begins superelevation of the outer rail at the heel of the frog and the other lowers the inner rail of the turnout when practicable.

For junction turnouts, frogs of No. 14 to No. 20 are used in general, corresponding to curves of 3 and 1½ deg. respectively. The former is considered satisfactory for speeds not exceeding 20 m.p.h. and the latter can be traversed at speeds up to 30 m.p.h. without discomfort to passengers. Recommendations of the American Railway Engineering Association give limits ranging from 9 m.p.h. for a No. 4 frog and 11-ft. switch rail to 40 m.p.h. for frogs Nos. 16 to 24 with 33-ft. switch rails.

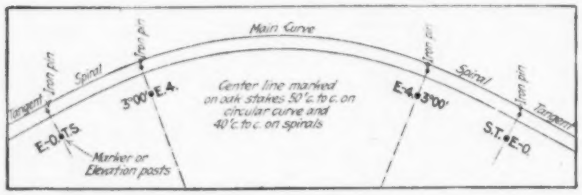


FIG. 1. MONUMENTING AND MARKING CURVES

Unless curves are permanently referenced or monumented and are checked occasionally from the monuments, the actual curve is likely to vary from the original or true location, due to shifting under traffic and rectification by the section forces. This permanent marking assists the work of maintenance and also the future adjustment or resurvey.

The monumenting consists in placing permanent stakes to indicate the beginning and end of curves and the change from spiral or compound curve to the main circular curve. The center line may also be staked permanently and it is a general practice to set posts showing the amount of superelevation. But the monumenting and marking of line and elevation are practiced systematically by relatively few railroads, and nine out of twenty-seven important roads report that they do not follow either method. Of the others, some mark line only or elevation only, while the remainder mark both and set curve monuments with more or less completeness. Some roads are introducing monuments and marks where curves are resurveyed.

Monuments consist usually of pieces of rail, iron stakes or wood posts placed outside the track and opposite the points of curve, spiral and tangent. On a few roads they are set also at intermediate points, as at 500-ft. intervals.

For marking alignment, center line stakes are placed generally at these same points, and sometimes at intervals of 50 ft. on the main curve and 25 ft. on spirals, as indicated in Fig. 1. Iron pins 1½ or 2 in. in diameter and 3½ to 4 ft. long are most commonly used for this purpose, but splice bars and oak stakes 2 x 2 x 24 in. are employed in some cases. A few roads use stone posts 6 x 6 x 36 in. and one of these roads specifies them for use in all slag ballast. Chisel marks on the iron and stone stakes and tacks in the wood stakes should mark the exact center line.

Instead of the usual terms *PC* and *PT*, one road has adopted the following nomenclature for points on curves, indicating the change as each point is approached: *TC*, from tangent to curve; *CT*, curve to tangent; *TS*, tangent to spiral; *SC*, spiral to circular curve; *CS*, circular curve to spiral; *ST*, spiral to tangent; *CC*, curve to curve (on compound curves).

Many roads follow the practice of indicating the superelevation at each curve by means of posts or signs which are set usually at the sod line or edge of roadbed, 9½ to 12 ft. from center of track and opposite the points of curve, spiral and tangent (see Fig. 1). At curves without spirals, the posts may be set opposite the ends of the runout, on either side of the point of curve. The location of these posts, however, is not always as exact as that of the curve monuments. Usually they are marked with the elevation: 0 at the *PC* or at beginning of runout and the full figure at *PS*, or at end of runout. In some cases, the first or zero post is marked also with the runout inclination (1 in. in 60 or 67 ft.) and the second post shows the full elevation and the degree of curve.

Two types of curve elevation posts are shown in Fig. 2. In the design at the left only the elevation is marked. In the design at the right the end posts have zero elevation on one side and "*T*" (tangent) on the other side; the inner posts show the full elevation and also the degree of curve (down to ¼ deg.). In this design the figures are in relief on malleable iron plates bolted to a creosoted post.

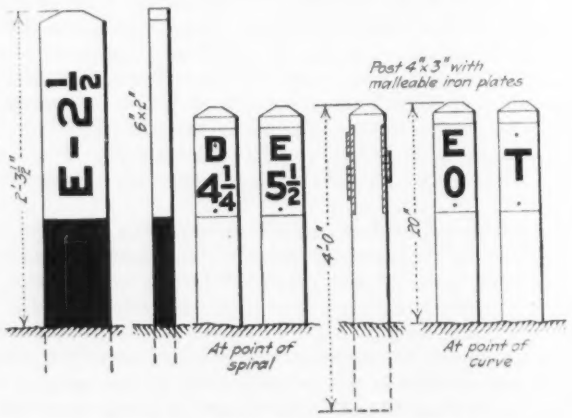


FIG. 2. CURVE ELEVATION POSTS

Diversity of opinion and practice in the widening of gage on curves, in order to facilitate the passage of locomotives, is as wide as the diversity in elevating rails on curves. Thus on twenty-two railroads standard gage is maintained up to curvatures ranging from 3 deg. as a minimum to 18 deg. as a maximum. In more detail, 3 deg. is the limit on one road, 4 deg. on two, 5 deg. on eight, 6 deg. on one, 8 deg. on six, and 9, 10, 12 and 18 deg. on one railroad each. Four roads report that gage is not widened at all on main track curves, two of them stating that their curvature does not require it. Of the other two, both operating long lines over prairie and mountainous country, one makes an exception for curves of 10 to 12 deg. through yards and the other states that locomotive tires are set to a gage which will allow for curvature.

Difference in wheelbase and wheel gage of large locomotives is theoretically a factor, but so many railroads

now operate engines of long wheelbase that this factor can have little weight in accounting for the diversity of practice noted above. The American Railway Engineering Association recommends standard gage up to and including 8 deg. curves, and then widening ½ in. for each 2 deg. up to a maximum of 4 ft. 9½ in.

Increments in widening are generally ½ in. for each two degrees (or fraction thereof) or ¼ in. for each 4 deg. On one road the rule is carried to a refinement of $\frac{1}{16}$ in. for each degree, beginning with 4 ft. $8\frac{5}{16}$ in. for 6 deg. curves. In this case, as in cases where rules require superelevation to be varied by increments of ¼ in., it may be doubted whether such close graduation is maintained in practice. For maximum gage permissible, including wear of rail heads, four limits are given by different roads as follows: 4 ft. 9 in., 4 ft. 9¼ in., 4 ft. 9⅜ in. and 4 ft. 9½ in. Rules sometimes specify the use of special track gages for curves to insure accuracy of widened gage.

Diversity of Practice in Gage Variation

The diversity of practice in regard to gage is emphasized by the contrasting statements in railway companies' books of maintenance rules quoted below, although in some cases these statements refer particularly to tangents. It is further noted in some of these books that kinks in gage are as detrimental as low joints in surface and must be corrected. In regard to the second quotation, other roads have rules which approximate the first sentence, but with the term "proper" or "uniform" instead of "perfect," thus giving a very different sense to the paragraph:

A. "Slight variations from gage are not objectionable, provided that they are uniform and continuous over long distances."

B. "Perfect gage is one of the principal features in good track. Gage must be exact and uniform as prescribed."

It is sometimes pointed out in the rules that rectification of gage need not be attempted as long as the width is regular or uniform and does not exceed certain limits. This caution provides against unnecessary labor and work and undue damage to ties and track material by the shifting and respiking of rails.

Turnouts on the inside of curves are objectionable, since standard gage is required through turnouts, so that the normal widening of gage must be interrupted. Some roads require speed reduction on such curves. With turnouts on the outside of widened curves, the standard flangeway width at main line guard rail is increased by an amount equal to the widening of gage.

Increase in gage is obtained usually by shifting the inner rail outward and is maintained for the full length of the main on circular curve. The transition from standard to widened gage is made in conformity with the spiral, or on the tangent if the curve is not spiralled.

A request for suggestions as to means of improving the stability or permanence of track on main-line curves produced but meager results. In general, the replies covered good maintenance and heavy track construction. The first includes correct alignment, with transition curves, uniform gage and uniform superelevation. One suggestion is to facilitate maintenance by placing 40-in. iron pins at all curve points, the center line being marked on the head with a cold chisel.

Suggestions for track construction include heavy rails, ample supply of good ties, well-drained roadbed, a heavy bed of crushed stone or gravel ballast kept well tamped, heavy tie plates, double spiking and the use of sufficient rail anchors or other means to prevent creeping. In view of the lateral pressures, some engineers suggest shoulder tie-plates, large ties and a heavy shoulder of ballast. Canting or inclining the rails inward from the vertical, so as to be perpendicular to the pressure, is advocated by two roads, one of which points out that this inclination should be given by special tie plates and not by adzing the ties. A corollary to this is the statement that in no case should the rails be allowed to turn out or incline outward from the vertical due to wheel pressure or tie wear.

Reduction of superelevation is the most radical suggestion, one engineer making this definitely and another indirectly by pointing out that if superelevation is increased to suit the speed the speed is likely to be further increased. In the first reply, it is remarked that such reduction probably will give greater relief than any other measure. It is considered specially desirable for tracks used by both fast passenger trains and slow heavy freight trains. On certain portions of this road, trouble from derailment has been practically eliminated by reducing the superelevation of 3 deg. curves from 5 in. to a maximum of 3 in. As it is expensive to carry out such a change over a considerable mileage it may be introduced in connection with other work, or when the track is being ballasted or surfaced.

Grade Compensation on Curves

To equalize train resistance it is usual to compensate or reduce grades for curvature, in order that the combined grade and curve resistance will not exceed the grade resistance on tangent. The present information given as to present practice in this respect supplements earlier information in *Engineering News* of April 16, 1908, p. 419, and Aug. 15, 1912, pp. 278 and 308. The rate of compensation should properly take into account the local physical and operating conditions.

Uniform compensation or reduction of grade at the rate of 0.04 per cent per degree of curve, regardless of variations of curvature and speed, is by far the most general rule, although some railroads specify or allow modifications to meet special conditions, especially in the use of increased compensation where steep grades reduce the speed or where stations may necessitate the stopping of trains. On one large system there is no prescribed rule but the matter is left to the judgment of the local engineers.

The minimum compensation noted is 0.03 per cent, used by two roads. The maximum is 0.05, used by three roads, though only one of these makes it a uniform standard. One engineer reports that dynamometer tests have shown 0.04 to be insufficient for sharp curves, and recommends going as high as 0.06 per cent. Out of twenty-four roads, sixteen use 0.04, mainly as a uniform rule. Two use 0.03; four use 0.035, one uses 0.045 and one uses 0.05.

Some of the modifications or qualifications for compensating grade on curves according to local conditions are noted below:

1. On maximum grades with a large amount of curvature, 0.04 per cent compensation is used up to 10 deg. curves, but this is increased to 0.05 on grades with few curves. Grade at sidings must not exceed 0.4 per cent. A decrease of 0.1 per cent in grade must be allowed for vertical curves.

2. Compensation is 0.04 per cent, the uphill end being equated and carried out on the tangent.

3. A good rule is 0.035, as 0.03 is scarcely sufficient and 0.04 makes the pull on the drawbar a little less on heavy curves than on tangents.

4. Although our rule is for a standard compensation of 0.04, a correct and scientific rule would recognize in some way the degree of curve as being a function of curve resistance. Thus if 0.04 is proper for a curve of 12 deg. it does not follow that it is proper for one of 2 deg.

5. Although the American Railway Engineering Association suggests 0.03 compensation up to 2 deg. curves, we use 0.04 for all degrees and have found it satisfactory.

6. Ordinarily, 0.035 is used, but this is increased to 0.04 on steep grades with sharp curves.

7. Ordinarily 0.04, but 0.05 at stations or points where trains are likely to stop.

8. Compensation is 0.03 on the open line and 0.05 at points where speed is restricted or trains stop.

9. Compensation is uniformly 0.04, for although present conditions may call for reduced speed at certain points we cannot tell when conditions of increased power or decreased tonnage may make it desirable to maintain regular speed. There should be a greater rate of compensation where the track is used by both freight and passenger trains, since there is more friction and resistance where the superelevation is adjusted for normal and safe passenger movements but also carries full-tonnage freight movements.

As to the basis of these rules, most of the reports state that it is general practice and experience and all of them state that no recent tests have been made. Two refer to tests made about twenty years ago, three accept the recommendations of the American Railway Engineering Association and one bases its practice upon the Wellington investigation of 1878.

Conclusion

From the information presented in this article it is apparent that considerable diversity of opinion and practice exists in regard to curve work. Since proper condition of curves is so essential to efficient operation and economical maintenance, it is rather surprising that the permanent marking and monumenting of curves is not more general. Such work is inexpensive and in many cases a policy of checking the curves and then marking them would be well worth while. As to means of increasing the stability of track on curves and thus reducing maintenance work and expense, suggestions are mainly for heavier construction, although an important suggestion is for a general reduction in the amount of superelevation of rails.

It is evident that present formulas for superelevation of rails on curves give results which are barely applicable under modern conditions. In fact, these results would be misleading if they were not modified materially in the light of actual experience. It is evident also that modern heavy locomotives with long rigid wheelbase constitute a factor that must be reckoned with in curve layout and maintenance. Variation in gage of driving wheels on different axles in order to facilitate the passage of curves is common practice, but there is little uniformity and the arrangement appears to be mainly arbitrary. Under such conditions the engineer is at a disadvantage in deciding what amount of widening of the track gage should be introduced on curves.

Curve elevation and grade compensation for curvature both involve scientific investigation as a basis, although practical considerations must modify the application of results thus obtained. It appears, however, that no extended modern investigations or tests have been made to determine the accuracy of existing methods or the extent to which mathematical analysis needs to be modified to meet modern conditions. Reliance is placed largely on tests and investigations made many years ago, when size of engine and weight of train were very different from conditions involved in present railway operation. On the other hand, even greater reliance is placed upon actual experience and observation, since theoretical methods now in use do not meet practical conditions. For these reasons, a broad and thorough investigation of train resistance under modern conditions with modern equipment appears desirable.

It has been pointed out that curve superelevation and alignment, with other items of track maintenance work, were neglected during the war and under government operation of the railways. Since the war, labor and other conditions have not been favorable to prompt restoration of normal standards of maintenance. Consequently, there is a wide field for revision and improvement and perhaps an opportunity for important innovations.

Year's Count of Traffic at Toll Bridge Analyzed

TRAFFIC figures covering a full year's count (July 1, 1920, to July 1, 1921) have been obtained by the State Highway Department of Connecticut at the toll bridge over the Connecticut River on the Old Saybrook-Old Lyme road, which is part of the shore route between New Haven and New London.

This road is a direct route between New York City and the summer resorts to the north. The bridge, therefore, carries a heavy tourist traffic with extreme

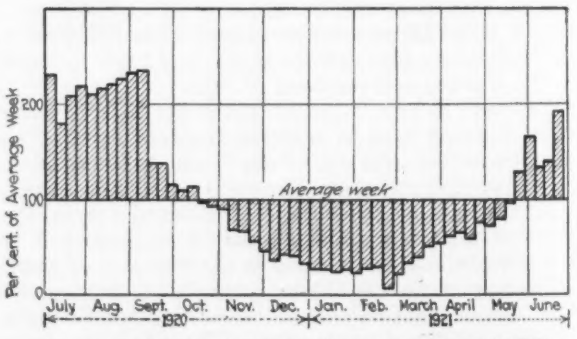


FIG. 1. TRAFFIC IN PER CENT OF AVERAGE WEEK

seasonal variations. The data have been summarized in the form of charts, which are reproduced herewith.

Fig. 1 shows a comparison of each week in the year with an imaginary "average week," obtained by dividing the total number of vehicles for the year by 52. On this particular chart the months of August, December and January have fairly steady weekly traffic.

Fig. 2 shows the division of the actually counted year's traffic on the Old Lyme bridge according to the days of the week. This is fairly representative of results obtained by short-period traffic counts. The chart represents the average of every Sunday, Monday, etc., for

the entire year reduced to the percentage of the weekly traffic. The Monday percentage in the case of this particular year is probably raised by two holidays—Labor Day and July 4.

Fig. 3 shows the monthly and seasonal variation in traffic. Had the astronomical summer period from June 21 to Sept. 21 been used, instead of the calendar months June to August, inclusive, over one-half the yearly traffic would have occurred in that quarter.

Fig. 4 indicates the relation of the various types of vehicles using the bridge. Horse-drawn traffic, it will be noted, is exceedingly small, only about 0.4 per cent of the total.

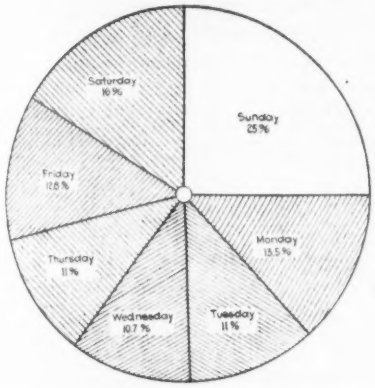


FIG. 2. DAILY VARIATION OF TRAFFIC IN PER CENT

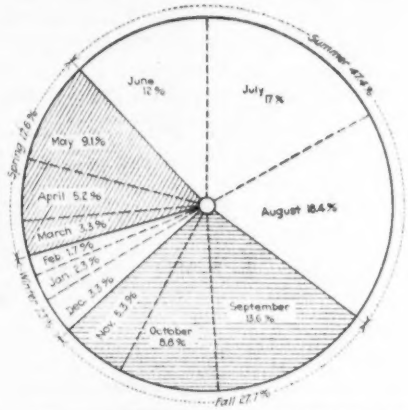


FIG. 3. SEASONAL VARIATION OF TRAFFIC IN PER CENT

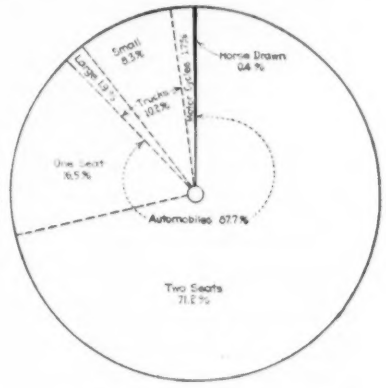


FIG. 4. RELATION OF TYPES OF VEHICLE

Varying Electrification Systems in England

A conflict of electrification plans has arisen in England, owing to the preference of three different systems by three railways which are to be included ultimately in one of the large groups formed by amalgamation of existing companies. Each of the three railways has an extensive suburban service near London. The London & Southwestern Ry. uses a 1,500-volt direct current system and the London, Brighton & South Coast Ry. uses a single-phase alternating current system. Now the Southeastern & Chatham Ry. proposes a 3,000-volt direct current system for its suburban lines. Such diversity being undesirable, meetings of electrical engineers and general managers were held in order to arrive at some basis of agreement. According to the *Railway Gazette*, London, these meetings were unsuccessful and the Minister of Transport has appointed a committee of electrical engineers and railway officers to consider the possibility of securing some degree of uniformity in future schemes for electrification.

Condition of Wood-Stave Pipe on Reclamation Projects

DATA on the condition of 196 separate installations of wood-stave pipe on 18 projects of the U. S. Reclamation Service are given in the December *Reclamation Record* by William H. Nalder, engineer, Denver office. He makes the following general observations:

1. One condition, which, while not universal, is in general quite typical of the operation of these pipe lines, is that they are full of water only part of the time, a condition generally recognized as conducive to the early decay and destruction of wood pipe.

2. Many installations are in soils that are more or less heavily impregnated with alkali and carry alkali-laden water. This contact with alkali appears to have resulted in several instances in the early destruction of the steel bands and wire winding of the pipe.

3. There are 65 installations reported as being made between the years of 1916 and 1920. All but three, or 95.4 per cent are reported in fair or better condition. The three installations reported in poor or worse condition were made in 1916 and 1917 and were of untreated fir staves placed in moist earth and kept full of water during the irrigation season only. They were in sizes of 10 and 12 in. and are under maximum hydrostatic heads of 10 and 15 ft.

TABLE I. WOOD-STAVE PIPE CONDITIONS ON U. S. R. S. PROJECTS

Condition	All Installations: Installations Number	All Installations: Installations Per Cent	All Installations: Amount Length, Ft.	All Installations: Amount Per Cent	1910 and Earlier: Installations Number	1910 and Earlier: Installations Per Cent	1910 and Earlier: Amount Length, Ft.	1910 and Earlier: Amount Per Cent	1911 to 1915, Inclusive: Installations Number	1911 to 1915, Inclusive: Installations Per Cent	1911 to 1915, Inclusive: Amount Length, Ft.	1911 to 1915, Inclusive: Amount Per Cent	1916 to 1920, Inclusive: Installations Number	1916 to 1920, Inclusive: Installations Per Cent	1916 to 1920, Inclusive: Amount Length, Ft.	1916 to 1920, Inclusive: Amount Per Cent
Perfect	1	0.5	1,030	0.3	..	.....	.....	.....	1	1.7	1,030	0.9	..	...	.....	.....
Excellent	7	3.6	16,182	3.9	..	.....	.....	.....	3	5.1	12,046	10.1	4	6.2	4,136	2.9
Very good	7	3.6	6,913	1.7	..	.....	.....	.....	3	5.1	4,158	3.5	4	6.2	2,755	1.9
Good	120	61.5	220,851	53.7	34	48.0	42,951	29.2	32	54.2	46,649	39.1	54	83.2	131,251	90.6
Fair	31	15.9	65,687	16.0	20	28.0	43,579	30.2	11	18.6	22,108	18.5	..	...	.....	.....
Poor	17	8.7	69,781	17.0	7	9.9	34,372	23.4	7	11.9	28,669	24.1	3	4.6	6,740	4.6
Very poor	5	2.6	9,603	2.3	4	5.6	9,091	6.2	1	1.7	5,122	0.4	..	...	.....	.....
Bad	1	0.5	3,930	1.0	..	.....	.....	.....	1	1.7	3,930	3.3	..	...	.....	.....
Almost useless	4	2.1	15,721	3.8	4	5.6	15,721	10.7	..	.....	.....	.....	..	...	.....	.....
No good	2	1.0	1,087	0.3	2	2.8	1,087	7.3	..	.....	.....	.....	..	...	.....	.....
Total	195	100.0	410,785	100.0	71	100.0	146,801	100.0	59	100.0	119,102	100.0	65	100	144,882	100

4. Of the 59 installations made during the period of 1911 to 1915, inclusive, 50, or 84.7 per cent, are reported as in fair or better condition. Of the nine in this group reported as being in poor or worse condition two are of untreated fir in moist earth, full during the irrigation season only, one is redwood buried in alkali soil that has destroyed the winding, two are untreated continuous fir laid in gravelly soil, and for four no information is at hand as to the nature of soil or continuity of service.

5. Of the 71 installations made during the period of 1910 and earlier, 54, or 76 per cent, are reported in fair or better condition. There are three installations made in 1901 and one in 1904 which are all the installations reported

as being made prior to 1905. All of these are reported to be in fair conditions, although all are reported as having been moved and relaid.

To eliminate as much as possible the personal element entering into the use of the terms ranging from "perfect" to "no good" in describing one condition of the pipe the data have also been grouped under the two headings "fair or better" and "poor or worse." It is thought that all pipe described as being in a fair or better condition still is giving satisfactory service and that all pipe described as in a poor or worse condition was not at the time of examination giving satisfactory service, although it may have been doing so shortly before that time. This segregation and grouping is shown in Table I under the same general headings as to dates of installation as those used in Table I.

TABLE II. CONDITIONS OF PIPE ACCORDING TO CONSTRUCTION

Construction	All Installations				1910 and Earlier				1911 to 1915				1916 to 1920			
	Fair or Better		Poor or Worse		Fair or Better		Poor or Worse		Fair or Better		Poor or Worse		Fair or Better		Poor or Worse	
	Lines	Length, Ft.	Lines	Length, Ft.	Lines	Length, Ft.	Lines	Length, Ft.	Lines	Length, Ft.	Lines	Length, Ft.	Lines	Length, Ft.	Lines	Length, Ft.
Wire-wound fir staves																
Buried	93	144,560	22	76,866	43	61,440	13	46,151	21	32,179	6	23,975	29	50,941	3	6,740
Above ground	27	44,191	2	1,087	5	5,188	2	1,087	7	13,006	....	.....	15	25,997	....	.....
Wire-wound redwood staves																
Buried	2	38,649	1	512	....	.....	....	.....	1	1,727	1	512	1	36,922	....	.....
Continuous fir staves																
Buried	14	26,445	2	8,624	1	3,500	....	.....	11	22,162	1	8,624	2	783	....	.....
Above ground	22	45,760	2	13,033	5	16,402	2	13,033	10	16,917	....	.....	7	12,441	....	.....
Continuous redwood																
Buried	1	450	....	.....	....	.....	....	.....	....	.....	....	.....	1	450	....	.....
Above ground	7	10,608	....	.....	....	.....	....	.....	....	.....	....	.....	7	10,568	....	.....
All types	166	310,663	29	100,122	54	86,530	17	60,271	50	85,991	9	33,111	62	138,142	3	6,740
Totals in percentages	85.1	75.6	14.9	24.4	76.0	59.0	24.0	41.0	84.7	72.2	15.3	27.8	95.4	95.4	4.6	4.6

Wisconsin Produces Aggregates Locally at Low Cost

Itemized Cost at One Quarry and Six Gravel Pits—One Pit Operated by Day Labor—Some of Best Material Never Washed

By H. G. Kuehling
Construction Engineer, Wisconsin Highway Commission, Madison, Wis.

QUALITY of material, plant equipment and operation, and other items entering into the production cost of local aggregate are seldom the factors which decide its use. Handling and transportation are the deciding factors. They will be a greater factor as road jobs reach out farther from shipping points.

The argument is sometimes offered that the average contractor is not an economical producer of material. This may be true. Where there is a difference from $2,000 to even $6,000 per mile in favor of using local materials, contractors and producers may as well make up their minds that the road will be built of them.

The cost at commercial plants in Wisconsin, is about 90c. per cubic yard based on 60c. a ton for sand, 70c. a ton for gravel, and a 1:2:4 mix. To this must be added the freight haul of about 40 miles (a very short haul for many states) which gives a freight cost of about 95c. per cubic yard and the cost of unloading, which will be 25c. more, or a grand total of $2.10 per cubic yard on board the vehicle that is to haul the material to the road.

The cost of the local material in the bins ready to spout into the hauling vehicle, on three jobs where the Wisconsin Highway Commission maintained a cost engineer during the past season, was less than 94c. per cubic yard. This was in the production of 60,844 cu.yd. of sand and stone actually used, the waste sand being charged against the used sand. These quantities were 18,717 cu.yd. in one pit that required washing and had a large quantity of boulders and so also required considerable crushing; 22,470 cu.yd. in a second pit that required washing and some crushing, and the remainder on a third job where four separate pits were used requiring four set-ups, with no washing but some crushing.

With this basic difference of over a dollar a cubic yard considerable additional expense would be justified in producing the local materials. And when there is added the fact that the haul from the local pit is very likely shorter than from a railway station, this difference will become more startling. The fact that some contractors will not like to produce material will not be an excuse for missing the above savings.

The uncertainty of output, both daily and total, is sometimes advanced as an argument against local pits. There is no particular difficulty in arranging a local pit to produce an average of 200 cu.yd. per day, enough to build over 300 ft. of standard 18-ft. concrete highway. This with many other facts and costs is shown on the accompanying table. This output can readily be doubled by increasing the plant capacity or by stock piling before paving operations begin, or by both methods.

The total output can be determined and fairly well defined by proper test pitting. It is true that in some cases pits have had to be abandoned. During the past year in Wisconsin one pit operated by a contractor was abandoned and commercial material shipped in. In this case, however, the contract covered just such a contingency and the contractor was paid 20c. per square yard extra. At that the contractor built an extra mile of concrete that was not planned to come from the chosen pit. The taxpayers still benefited to the extent of 20c. per square yard on many thousand yards. While isolated cases may fail in total quantity, there is no special reason to expect failure where proper test pitting is done under the supervision of a competent geologist.

In speaking of daily output, the local pit must not be too severely condemned as we have all seen many jobs short of material even when commercial pits were furnishing it. This may have been due to breakdowns or changes in the pit, for such do occur; inability to get railway cars in sufficient quantities; too ambitious producers who contract for more than they can ship and then try to keep all customers going with partial orders; or to irregular deliveries by railway companies which are anxious to move more important and better paying freight. In the case of the local pit, the troubles, where they do exist, are close to the job and the work

can be better planned than when the contractor does not know whether or not he is to get a shipment on the siding.

Still another argument sometimes presented against local materials is that they are not as good in quality as commercial materials. This argument is not generally sound, for local material from the same glacial deposits as the commercial aggregates will give the same quality of sand and gravel if treated in the same way, just as crushed stone from two parts of the same ledge is the same if both parts are crushed and screened alike.

There seems to be a rather common impression that to be good concrete aggregate, the material must be washed. Some of the best material produced in Wisconsin is never washed and would only be harmed if it were. Many concrete road gravels are injured by too much washing which removes the finely-divided silica which should be retained to give a more nearly perfect gradation in the sand. There is no doubt that washing increases the output and assists in separating the sand from the coarse aggregate, but one should not overlook the fact that it might be harmful. A small amount of finely divided clay is not harmful and may be even beneficial, while the presence of the fine silica or lime dust mentioned above is decidedly beneficial.

The cost table accompanying this article is one that has been compiled from very carefully obtained data, based on actual expenditures. It is based on a regular scheme of cost information used by the Wisconsin Highway Commission. In a similar way the operations on several day labor paving jobs have been studied and carefully subdivided. This particular table also includes the costs of a day labor quarry operation which might be of some interest. This table warrants study by anyone contemplating local gravel production. It shows where best to concentrate efforts to cut down costs and another year's operation by these same counties will cut down the costs shown in this table.

COST OF PRODUCING GRAVEL AND STONE FOR CONCRETE ROADS FROM LOCAL PITS IN WISCONSIN.

	Washington Co.		Rock Co.				Winnebago Co.
	Slinger	Jackson	Pit No. 2	Pit No. 3	Pit No. 4	Pit No. 5	Neenah Quarry
C.Y. sand produced	5,541	7,539					
C.Y. stone produced	13,176	14,931					8,614
Total produced	18,717	22,470	4,170	5,559	3,932	5,996	
Days operated	90	104	24	27	18	34	127
Ave. daily production, C.Y.	208	216	174	169	218	176	68
Max. daily production, C.Y.	425	432	272	278	303	317	
Operation	Cost per C.Y.	Cost per C.Y.	Cost per C.Y.	Cost per C.Y.	Cost per C.Y.	Cost per C.Y.	Cost per C.Y.
Cost of undeveloped pit	.040	.044					
Cost of material in pit			.129	.100	.101	.162	.100
Assembling and erecting equip.	.152	.039	.170	.062	.056	.021	.072
Moving equip. during const.	.001	.003		.130	.218	.079	
Returning equip. to storage		.001				.068	
Stripping	.085	.047	.187	.060	.048	.131	
Drilling—Labor							.135
Drilling—fuel, oil, etc.							.042
Drilling rental of equip.							.161
Drilling depreciation of equipment							.020
Repairs to rented equip.							.011
Blasting—Labor							
Blasting dynamite, caps, etc.							.091
Breaking up rock							.013
Delivering to crusher—labor	.158	.012	.085	.057	.067	.058	Those items charged to crushing and screening
Delivering to crusher—fuel	.038	.029	.056	.026	.045	.075	
Delivering to rental equip.							
Delivering to dep. equip.	.108	.124	.050	.064	.058	.057	
Delivering to rep. to equip.							
Crushing & screening—Labor	.113	.232	.060	.067	.053	.077	.668
Crushing & screening-fuel	.018	.024	.057	.043	.076	.041	.133
Crushing & screening rental of equip.	.011	.005					
Crushing & screening dep. of equip.	.095	.043	.135	.112	.118	.116	.146
Crushing & screening repairs to rented equip.							
Washing—Labor pumping	.025	.017					
Washing—fuel & oil	.013	.007					
Rental & dep. of equip.	.023	.037					
Water rent	.017						
Handling waste material	.030	.021	.125	.040	.086	.063	.030
Stock piling & storing	.008						.046
Rehandling & loading—Labor	.007						
Rehandling & loading—fuel							
Rental & dep. of loading equip.							
Repairs to loading equip.							
Transporting men to & from job	.008	.004					
Supervision & recording	.056	.041	.148	.080	.092	.104	.032 .043
Small tools	.007	.012	.005	.013	.041	.020	.016
Camp loss			.010	.010	.010	.012	
Lost time of equipment				.001			
Watchmen							
Waterboys				.024	.022	.009	
Maintaining pit road	.003		.007	.022	.002		
Blacksmith							
Totals	1.016	.742	1.194	.913	1.115	1.098	1.759

Fireproof Office Building Gutted by Severe Exposure Fire

Upper Half of 15-Story Burlington Building Swept Clean—Unprotected Windows on 80-Ft. Street Appear Main Factor

HALF the contents of the 15-story office building of the Chicago, Burlington & Quincy Railroad Co., Chicago, were completely destroyed on the night of

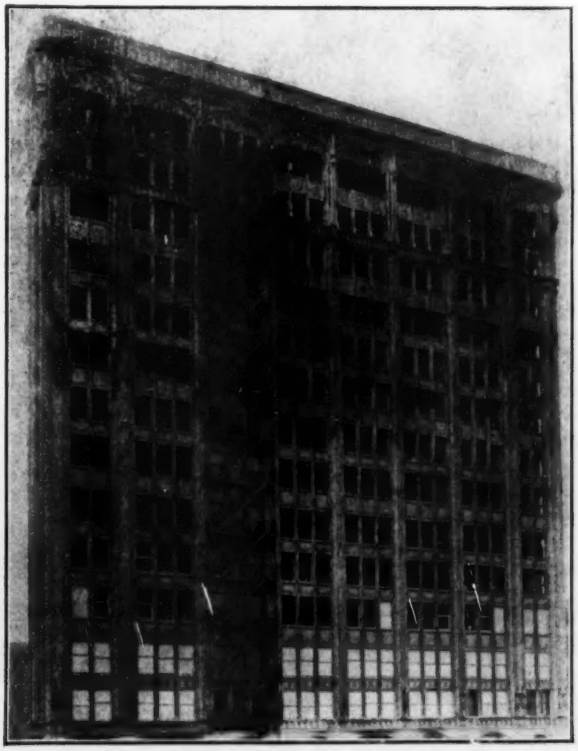


FIG. 1. BURLINGTON OFFICE BUILDING AFTER THE FIRE

Upper seven stories completely burned out; most of the terra cotta facing, particularly around windows, spalled. Note resistance of wire-glass windows behind fire escape.

FIG. 2. SOUTH COURT FACE

Wire-glass windows in metal frames here. Many panes melted in the fire, though little heat from outside fire reached this side.

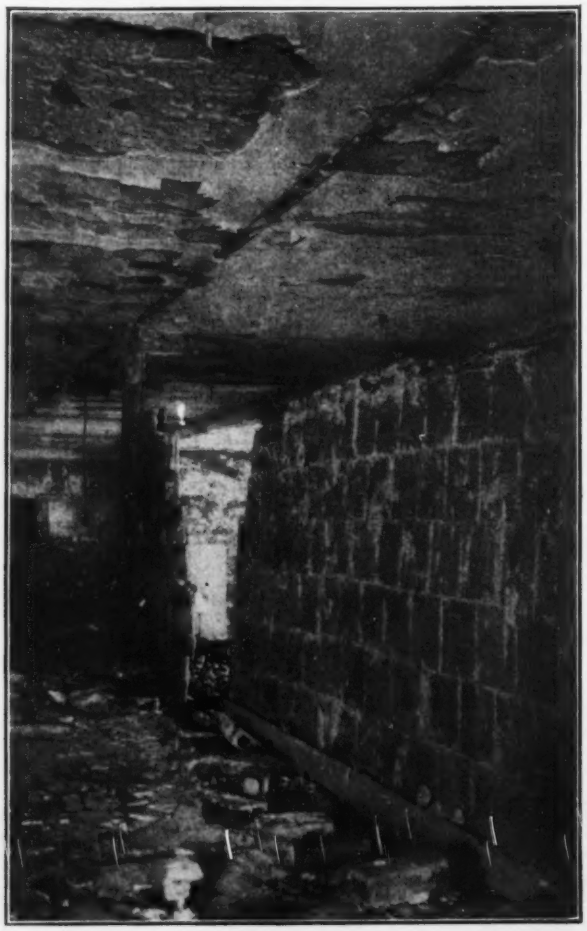


FIG. 3. TILE PARTITION AND CEILING DAMAGE

Expansion of floor tiles threw down plastering in patches. One or two soffits spalled off.

FIG. 4. REMAINS OF FILING CASES ON FIFTH FLOOR

Damage to mullions and window frames. A short fire and little water indicated by condition of the ceiling plaster.

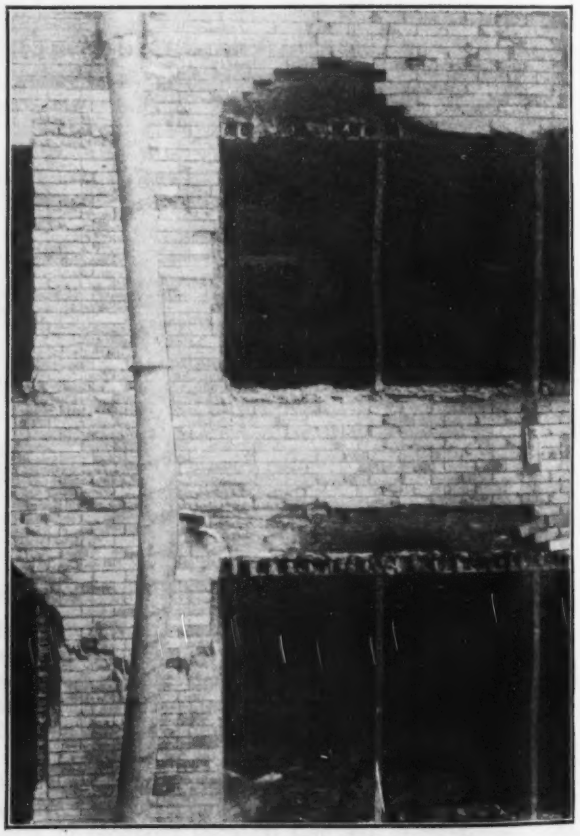


FIG. 5. BENT MULLION SUPPORT STRIPPED

Wire-glass sash and frames gone in court on fourteenth floor.

Inside Views of Burlington Building after Fire

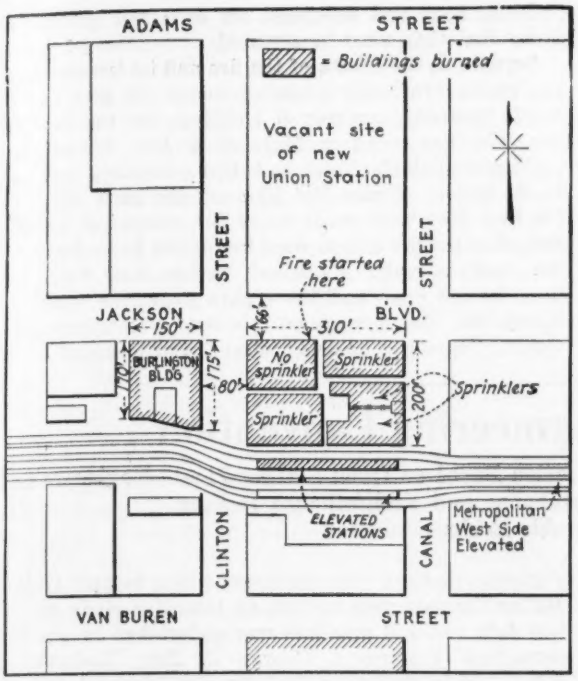


FIG. 6. LOCATION PLAN OF BURLINGTON AND ADJACENT BUILDINGS

March 14-15 by a severe exposure fire. The fire originated in the block directly east of the Burlington Building occupied largely by 2- and 7-story buildings. The flames swept across an 80-ft. street through the open floor areas of the Burlington Building above the eighth floor. The Burlington Building was of fireproof construction, but its unprotected street-front windows, plain glass and wood sash and frames, offered no resistance to the entrance of the furnace-like blast from the east. A light northeast wind prevailed. The steel elevated structure of the Metropolitan West Side Elevated Railway, extending along the south side of the burning buildings and the Burlington Building was much damaged by the heat, and a falling wall wrecked several girders, interrupting traffic for 15 hours.

So far as yet determined, the fire started in a 2-story building in the north side of the block bounded by Jackson Blvd., Canal, Van Buren and Clinton Sts. It spread rapidly southward through unprotected wall openings to the 7-story buildings, which were sprinklered. The engines were delayed some few minutes due to a false alarm. In the sprinklered buildings so many heads opened that the tanks were soon drained. The intensity of the heat generated in these buildings was exceptional, due to the character of the occupancy, light manufacturing, printing, book binderies and publishing. After the stream of fire gained entrance to the Burlington Building and melted out the wire-glass windows with which the openings in the rear were protected, it is reported that flames 30 ft. long shot out of the back windows. The Burlington Building was not sprinklered.

Interest from the engineer's viewpoint largely centers on the fireproof Burlington Building, where damage to structural members was little or none; the concrete and tile covering of the steel frame adequately protected the columns, beams and girders, but not without a certain amount of spalling. In spots the flat-arch tile floors lost the soffits of the tile.

The floor plan is open with the elevators grouped in a fireproof partition in a central location on either side of a corridor to the north of the court. The elevators were running up to the fifth floor the next day after the fire, no damage being done to the mechanism. The elevator inclosures were protected with wire-glass and are bulged outward several inches toward the corridor. There is no vent over the elevator shaft. Marble in the halls and elsewhere shows crumbling. The wood flooring and 2 x 3-in. sleepers in the cinder concrete were burned out clean. Steel filing cases and other steel equipment proved to be of little or no protection to their contents.

In general the fire damage was confined to the upper seven stories. The heat effects from the east are obvious on the spalled terra cotta work, of which perhaps half will have to be replaced. Large areas show where the glazing had been removed by the high temperature. The fire was intense and quick. Temperatures reached upward of 2,000 deg. F.; brass, which melts at 1,960 deg., is spattered around. The wire-glass windows melt at 1,700 deg. A clock hanging on the wall of an executive's office was found on the floor with the hands, after straightening, pointing to 1:45 p.m. The fire is reported as starting at 1:00 a.m. Other evidence of the short duration of the fire is the condition of plaster, which is practically intact in some of the top floors. Plaster calcines through in 30 to 40 minutes.

Losses of records by the Burlington are in many cases irreplaceable but G. A. Haggander, bridge engineer, states that most of the bridge plans were in fireproof vaults. On the other hand, many of the building plans and those of the signal department are gone. Valuation records are mostly gone and will have to be reassembled from Washington and points on the road. Most of the legal records are intact in the vaults. Steel office furniture and filing cabinets were of absolutely no protection to their contents.

Theories—The fire swept through the building horizontally. All evidence from several reliable sources indicates that the vertical stops at stairways were absolutely effective.

Charles Bostrom, city building commissioner, expressed the opinion that had all of the east windows been of wire-glass the first could have been kept out of the building. W. D. Matthews, chief engineer, Chicago Board of Underwriters, would not go so far concerning the effectiveness of wire-glass, but said that the firemen would have had a much better chance to save the building. The outside heat in his opinion prevented radiation from the fire caused by the ignition of office equipment within and this inside fire became so intense that it finally melted out the wire-glass windows in the rear.

Opinion, however, seems to be somewhat divided as to whether the wire-glass windows back of the fire escapes on the east face next to the fire were melted down from the fire inside or the heat from the outside. Employees of the elevated state that flames issued outward toward the east from some of the top floors. At any rate, the outside flames were not playing on the melted wire-glass windows on the rear of the building.

Dividing the destroyed block of buildings east and west is the elevated structure with the Canal St. sta-

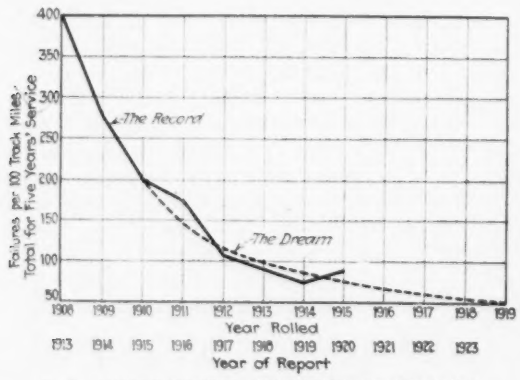
'ion in the middle of the block. Brick walls and machinery falling on the north island station and three of the four tracks, put three tracks of the elevated service out of commission for 15 hours, when the plate girders under one of the tracks had been jacked back into place and rails relaid. The east track to the south was out of commission from the heat and hose lines only. The heaviest load dropped onto short, shallow box girders which carried the tracks over the under passage between the two island platforms. While the temperature of the girders was high, B. J. Fallon, general manager, Chicago Elevated Ry., is of the opinion that those which are in place can be used, although on the north track the damage from the falling walls twisted, bent and deformed six or seven girders, so badly that they must be replaced.

Reports on the effects of the fire and its lessons to the profession are being prepared under the direction of W. T. Krausch, engineer of buildings for the Burlington, who has called in Marshall & Fox, the original architects of the building, and their consulting engineer, L. E. Ritter. Under Mr. Krausch the bank offices on the first floor were made ready for occupancy the next day after the fire and so were five of the lower floors for the road's officials. By March 18 two more floors had been turned over and the eighth floor was ready by March 20. The damage on this floor was mostly from water. There was no delay to service or business.

American Railway Engineering Convention

Rail Committee Presents Experimental Rail Specification Based on Quiet-Setting Steel—Engineers and Labor Economics—Analysis of Warehouse and Freighthouse Design —Specifications for Movable Bridges Adopted

A DISTINCTLY progressive attitude in the work of the American Railway Engineering Association was evidenced in the committee reports presented at the annual convention held in Chicago, March 14-16. The most important action was the development of a new experimental rail specification, to which the manufacturers have agreed to roll rail. Four other important developments which mark departures from more or less



RAIL IMPROVEMENT INTERRUPTED IN 1915

Five-year performance of rails rolled in various years (full line), and predicted curve of M. H. Wickhorst (dash line).

routine investigations may be noted: (1) Application of economics to the labor situation, covering not only the selection and employment of common labor, but also the training of young engineers and of employees in the maintenance-of-way department; (2) Analysis of the main principles and factors in the design of railway warehouses and freighthouses, in order to insure efficient and economical operation; (3) Preparation of a system of records for unit costs in track work, so that there may be a definite knowledge and comparison of costs in various items of work; (4) Preparation of definite specifications for special classes of track work in view of the steady though as yet slight tendency toward the contract system in maintenance of way. Advance in the field of bridge design through the adoption of a specification for movable bridges was still another item of progress.

Following the disagreement of view between railway engineers and rail manufacturers which became evident during the past year or two, an intensive study of rail test data and mill practices was undertaken by the rail committee (chairman, George J. Ray, Lackawanna R.R.). This study led the committee to certain conclusions as to desirable qualities in rail steel, on the basis of which a trial specification was framed. The rail mills have agreed to roll rail to this specification. The committee states its conclusions thus:

> Probably the most important item of manufacture that affects the quality of the finished rail is the condition of the steel as it is poured into the molds. A well-made steel, thoroughly deoxidized with silicon or other deoxidizer, sets quietly in the molds with a flat top on the ingot. A steel not fully deoxidized, however, effervesces in the mold and sets with a "horney" top on the ingot. The upper third of an ingot cast with effervescing steel is spongy inside, with numerous small holes but with only a small central pipe. Such steel also shows considerable interior segregation of carbon, phosphorous, and sulphur, resulting in a brittleness in the interior of the head of the upper rail of the ingot. The quiet-setting steel is free from interior sponginess, the segregation is much lower, and the interior steel of the upper third of the ingot is denser and more ductile, but the ingot has a larger central pipe, which shows as a lamination in the web of the rail lower down from the top of the ingot than in rail made from effervescing steel.
>
> The work by Wickhorst in 1912 (see *Proceedings* American Railway Engineering Association, Vol. 14, 1913, p. 507), showed that about 0.25 per cent or more of silicon is required to obtain its full deoxidizing effect, and it would seem that specifications should require a minimum of 0.20 per cent silicon in rail steel. In this case the upper end of the *A* rail, with the usual discard of 10 or 12 per cent, may show a small vertical lamination in the web, but the metal in the head will be free from the sponginess and excessive segration present in rails made with effervescing steel.

These conclusions, and the expectation that with careful mill practice the normal amount of top discard will insure good rail steel, are reflected in the experimental specification which was submitted at the meeting for information. Some of its characteristic features are:

Chemistry—Carbon, from 0.53-0.68 per cent for 70-lb. rail to 0.67-0.80 for rail over 111 lb. Phosphorus, 0.04 maximum. Manganese, 0.60-0.90, with 0.50-0.80 optional for rail over 111 lb. Silicon, *not less than* 0.20 per cent.

Tests—Specimens *shall not fracture* in the drop test; ductility and deflection are to be measured for information only. Either one blow or two blows with reduced

height of drop may be demanded by the purchaser; with the standard 2,000-lb. tup and 3-ft. span (4 ft. for rails over 111 lb.), the two-blow drop is specified as 15, 15, 16 and 18 ft. for rails of 70-79, 80-90, 91-110, and 111-140 lb. weight. If one blow is used, the heights for 80-90, 91-110 and 111-140 lb. are to be 18, 20 and 23 ft. There are carefully guarded provisions for retest in certain cases. All tests are to be made *with head down.*

Desired Mill Practice—Fully deoxidized, quiet-setting steel is desired, teemed into the molds as cool as practicable. The ladle should be held as long as practicable, so that all reactions may become complete. Ladle additions should be made in liquid form. Aluminum addition in the mold is not permitted. Spattering in teeming, and disturbing the crystallization of the steel in the molds are to be avoided. The top discard must be such as to remove injurious segregation and pipe. Careful procedure on the hot beds and in the straightening press is demanded. As indicated, most of these provisions are informational and not mandatory.

Production of rails under these specifications during the next year is to be accompanied by thorough study of the mill practices actually realizable thereunder, and the results in rail quality obtained.

Other Points of Rail Study

Rail failure statistics for 1920 and their correlation with those of previous years confirm the indication obtained previously that the war-time rollings are decidedly inferior to those just preceding. The steady reduction in rail failures since 1908 was interrupted, beginning with the 1915 rollings, in the way brought out by the curve reproduced herewith, which reports the total failures in five years' service and shows their remarkable concordance with an improvement curve predicted six years ago by M. H. Wickhorst, engineer of tests to the committee. More light is thrown on the quality of the war-time rails by the record for shorter periods of service. Thus, the rails rolled in successive years from 1910 to 1917 gave, in three years' service, the following number of failures per 100 track-miles: 124, 104, 49, 45, 33, 34, 48, 86. The one- and two-year service records indicate an improvement in quality in the rollings subsequent to 1917.

Designs for rails weighing 150 lb. per yard have been considered, to supplement the series of sections up to 140 lb. heretofore designed. A memorandum on this subject by W. C. Cushing (Pennsylvania R.R.) stated that heavier sections than yet rolled are under consideration by various large railroad systems, that the relative importance of size of head (for wear under heavy traffic) and depth of section (for girder strength under lighter traffic) is the crucial point, and that the RE section, which appears to be most suitable for the heavy rails, is under study for the 150-lb. weight.

Discussion by Hunter McDonald (Nashville, Chattanooga & St. Louis Ry.) and J. L. Campbell (El Paso & Southwestern R.R.) proposed that the desirability of longer rails be restudied. The former said that 66-ft. rails seem desirable, while Mr. Campbell said that western roads are considering 39-ft. rails. Other work reported by the rail committee included a schedule of recommended practice for rail inspection, which was accepted. A formula by M. H. Wickhorst for elongation of rails in the drop test was presented. It is,

$$E = \frac{4.8\,h}{X\,(C + 0.30)}$$

where E is percent elongation in maximum inch on first blow for 3-ft. span, h is height of drop in feet of a 2,000-lb. tup, X is the section modulus of the rail, and C is the per cent carbon content.

Study of joint bars is still in progress. Investigation of the intensity of wheel pressure on rails has been deferred for the time being.

In a brief progress report the committee on Economics of Railway Location expressed the opinion that no information of value is obtainable concerning the effect of curvature on cost of maintenance of way and equipment. Although it would be possible to work out a number of factors by means of extended research and experiment, the practical value would be doubtful since it would be impossible to reconcile the test results with the practical conditions of operation. On the other hand the committee on Economics of Railway Operation discussed analytically the determination of traffic capacity of a railway, and proposes to extend this discussion to show the economic development through changes in motive power, additional tracks, grade revision, signals and other facilities.

Another important subject in close relation to that of traffic capacity is the economical operation of trains against the current of traffic on lines having multiple tracks. This includes the operation of a third track by trains in opposite directions according to traffic requirements, a practice followed by 14 roads having over 4,000 miles of multiple-track lines. Concerning the relation of speed to cost of maintenance of way, the conclusion was reached that this cost increases with speed but that no exact relation can be established.

Labor Economy Important

That labor economy is now fully as important as economics of materials, but has received much less attention and therefore affords a wide field of improvement, was emphasized in the report of the committee on Economics of Railway Labor. Two highly desirable lines of development are: (1) The establishment of a single central authority to supervise the selection and care of all employees on a railway system; (2) the establishment of units of measure of the work performed in track maintenance. At present the records of track work are mainly those of expenditures. The report submitted methods of establishing such units and of reporting such work so that its cost may be distributed in accordance with these units.

The disadvantage of the present employment system, which results in large labor turnover, was noted in the discussion. It was pointed out, also, that under the system of seniority rights of employees it is important in employing new men to select only those who appear to be adapted to railway service. Methods of training employees in order to promote efficiency were outlined.

Training Engineers—Technical employees were included in this report, one section of which deals with the training of young engineers in railway work. This does not include methods of obtaining engineers, though it pointed out that consideration should be given to the engineer who has not had a college training. The president, L. A. Downs (Central R.R. of Georgia), in his opening address, urged the necessity of greater cooperation with the engineering schools and a much more

liberal rate of pay to make railway service attractive to the young engineering graduate. According to the committee report, a fixed minimum engineering corps, giving greater promise of permanent employment and opportunity for promotion, is necessary in order to encourage men to remain with the company. It is of particular interest to note that the report and the discussion pointed out the desirability of railway engineers making themselves familiar with operation.

Animated discussion developed on the subject of the engineer's career in railway service. J. A. Stocker (Toledo & Ohio Central Ry.) expressed the view that the older engineers do not take a helpful attitude toward the beginners in the service, and that this has a discouraging effect. C. E. Lindsay (New York Central Lines) suggested that a well-defined line of advancement should be marked out in engineering service; others recommended that opportunities for engineers should be provided also in other departments. Prof. A. N. Talbot pointed out the great decrease in the attractiveness of the railway career to young civil engineers within the last generation, and expressed the hope that the condition may be improved in the interest of the railways themselves.

Track Ditching—Touching the question of labor economy was a brisk discussion of the economic aspect of railway ditching. In dealing with methods of ditching, the committee on Roadway was content to list and describe the various methods employed, no attempt being made to discuss their relative economy. Objection was made promptly to the action of the committee in recommending hand work under certain conditions. The point was made by R. H. Ford (C., R. I. & P. Ry.) that such action is fundamentally wrong, since hand labor is so expensive that although it may sometimes be used, it certainly should not be included by the association in its "recommended practice."

The report classified ditching according to varying depths of cut, but in discussion the argument was made that machine work is economical and practicable under all conditions, regardless of depth of cut and density of traffic. By a large vote it was decided to refer back to the committee all of its conclusions on ditching, with the exception of the opening statement: "Good roadbed drainage is the foundation of economical track maintenance; therefore, the ditching of cuts is of great importance and should be carried out currently with the regular yearly maintenance program."

Studies of time and cost of unloading and placing ballast, together with the force organization of the work, were the subject of a detailed report by the committee on Ballast. A proposed organization for a small ballasting gang was submitted and adopted.

Contract Work—Interest in the modern development of contract work for railway maintenance was indicated by a report of the committee on Track, which submitted complete specifications for contract work in relaying rails, renewing ties and ballasting. These specifications were proposed for the "Manual," but objection was made to this on the ground that they are new and untried and that in view of the very indefinite status of the contract system for track work it would be unwise to adopt such specifications. It was voted, therefore, to accept them as information.

Tie Records—Difficulties in comparing the life of ties due to uncertainties as to kind of wood and conditions of use, led the committee on ties to suggest that all test installations should include white oak ties of specified grade and size to serve as a basis of comparison. This recommendation was adopted after active discussion of the difficulty of fixing a standard of white-oak quality. The committee recommends that treated ties should have spike holes bored and tie-plate seats faced by machine, but that the expense of boring untreated ties for cut spikes is not warranted. As to cut and screw spikes, good track can be obtained with either, but there is no evidence as yet that the latter prolong the life of the tie.

The use of dating nails for treated ties was advocated by the committee on Wood Preservation, but F. J. Angier (B. & O. R.R.), a member of the committee, made strong objection to this. In his opinion the expense is too great to be justifiable, and dating nails should be used only in test ties. The chairman, C. M. Taylor (P. & R. R.R.), and other speakers took the position that without the nails there is no possibility of keeping reliable records of life of ties, while their presence warns the section foreman against premature removal, since he knows that his records of tie removal will be checked by superior officers. A vote on the question showed a large majority in favor of using the dating nails in all treated ties.

Considerable discussion attended the presentation of standard designs of track tools by the committee on Track, but it was voted to adopt them. As designs of shovels were submitted independently by the committees on Track and Ballast these committees are expected to get together and harmonize their plans. Designs for managanese-steel track crossings were adopted. Plans for location of track signs uniformly at 10 ft. 4 in. from center of track were adopted, as submitted by the committee on Signs, Fences and Crossings.

Analysis of Building Design

Two reports dealt with the operating factors affecting the design of railway warehouses and freighthouses. Such factors include length of trackage, tailboard space, elevator capacity, turnover of freight, etc., in relation to floor area and tonnage handled. Thus, with a knowledge of traffic conditions at any point, the engineer has a number of constants or ratios to guide him in designing an economical and adequate structure.

A study of the design of multiple-floor warehouses over railway freighthouses, in order to develop the air rights of the property site, was presented by the committee on Yards and Terminals. This is a subject on which very little information is available, but which has been given considerable attention in planning large new terminal developments at Chicago. A somewhat similar study of the design of L. C. L. freighthouses was presented by the committee on Buildings, which pointed out that too frequently the size of the freighthouse is determined arbitrarily and the design is based upon approximations and comparisons with existing freighthouses, whereas the traffic should be analyzed in regard to its character and extent and the building design then based upon these local conditions.

Of a more general and descriptive character was the matter submitted by the committee on Buildings in regard to ice houses and icing stations, and by the committee on Shops and Locomotive Terminals in regard to engine houses and car repair shops. This

latter committee pointed out that engine terminal development has lagged so far behind that of equipment that many terminals are inadequate for efficient service. In fact, in many cases improvements which will reduce the time required for turning and handling engines will be equivalent to the provision of additional power to the division. Other matters submitted by the committee on Buildings included specifications for structural steel and iron, stone masonry, tile, marble, plumbing, treating, painting and glazing. These were adopted, and will form part of a comprehensive set of specifications for railway buildings.

Standards and Contracts

Waste due to useless diversity of types was urged by the special committee on Standardization (which is composed of the chairmen of the other committees) as indicating the great need for standardization. Several speakers suggested the desirability of closer relations with the American Engineering Standards Committee and it was voted to submit the following specifications to that committee: (1) Cast-iron pipe, valves and hydrants; (2) track tools; (3) railway lamps; (4) ties; (5) insulating tape, subject to approval of certain of these by the association.

A resolution was passed to the effect that within one year after the adoption by the Association of a "recommended practice," the Board of Direction may present such project to the American Engineering Standards Committee.

Discussion of specifications for movable bridges has been in progress for several years, after a first draft had been prepared by the committee. The final document was worked out during the past year, and was approved by the meeting as a standard. An important revision made by the committee at the meeting changed the tread pressure in rolling bridges from $125\,d$ to $3{,}200\,\sqrt{d}$ per linear inch, d being the diameter of the rolling segment in inches; it also changed the allowable web contact pressure under such treads (within 45-deg. planes) from 7,500 to 13,000 lb. per sq.in.

A short set of specifications governing the erection of steel fixed bridges (for spans less than 300 ft.) was also presented. These specifications were received as information, and are to be under study for a year before adoption. Comment was made on some of its clauses, chiefly with a view to securing more precise definition of work-train service and adequate clearance between track and piled material. The general criticism was made that the specifications largely cover matter forming part of the contract; but it was stated in reply that these particular elements of the contract need to be in the hands of the men on the work and should therefore be part of the specifications.

Several minor revisions were made in the specifications for fixed bridges adopted two years ago. The permissible compression in flanges of beams and girders was fixed at $16{,}000 - 150\,l/b$.

Classification of bridges, specifications for turntables, and specifications for highway bridges, are to be matters of study during the coming year. Work may also be done on column tests, on electrically welded connections, and on signaling and lighting drawbridges. It was stated that there is ground for believing that if uniform rules for lighting drawbridges are adopted they will be accepted by all government authorities having jurisdiction. A standard already exists in Canada.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Floating-Ginpole Method Patented

Sir—The writer was greatly interested in the very instructive article on the erection of 400-ft. radio towers which appeared in your issue of Feb. 9, 1922. He was somewhat surprised and disappointed to find that no mention was made of the fact that the Pittsburgh-Des Moines Steel Company developed the floating ginpole described and holds patent on the same. Permission was given to the American Bridge Co. to use this device on the Long Island job.

This invention was developed by members of our organization; U. S. patent 1,182,387 was granted to one of our employees on May 9, 1916, and was subsequently assigned to the Pittsburgh-Des Moines Steel Co. We have been using this device for the erection of steel towers for a number of years. It may be of interest to your readers to know that we shipped four of these poles to France and used them in erection of the eight 820-ft. towers of the Lafayette Radio Station at Bordeaux.

GEO. L. CHRISTY,
Chief Engineer,
Pittsburgh-Des Moines Steel Co.

Pittsburgh, Feb. 24.

Proposed Clauses for Structural Specifications

Sir—In applying to Bethlehem shapes the formula for buckling resistance of webs which is given in the Carnegie handbook, 19,000 — 100 d/2r; it seems to the writer that it would be better to go a step farther and add "= 19,000-173. 2 d/t" also giving a limit of 16,000.

In connection with web resistance to direct compression, are not our building codes conspicuously silent? This is one of the points which may well be covered in the proposed standard building code. Other matters which might be more satisfactorily specified are the spacing of plate-girder stiffeners, unit stresses for beams without lateral support, and unit stresses for threaded rods. On all of these questions there is a wide difference in practice and little that is definite in codes and specifications.

These latter points were covered in the following manner in the specifications for building work used by Westinghouse, Church, Kerr & Co. prior to their merger with Dwight P. Robinson & Co.

Plate-Girder Stiffeners—Web stiffeners shall be provided, generally in pairs, over bearings and under concentrated loads. They shall be proportioned for bearing at 24,000 lb. per sq.in. on the actual contact area and not over 16,000 lb. on the gross cross-section. There shall be a sufficient number of rivets to transmit the full load to the web. These stiffeners shall be placed on fillers, have an absolute end bearing on flange angles, and the outstanding legs shall be as wide as the flange angles will allow. Intermediate stiffeners shall be provided if the unsupported depth of web between flange angles is more than sixty times its thickness. The clear distance between stiffeners shall not exceed 72 in. or t/40 (12,000-s) where t is thickness of web in inches and s is shear in pounds per square inch.

Beams Laterally Unsupported—The compression flanges of beams and girders shall be stayed at intervals not exceeding fifteen times the width of flange, or else the unit stress in pounds per square inch shall not exceed 19,000-200 L/B, or, when cover is in the form of a channel or beam, 19,000-150 L/B with a maximum of 16,000, L being the unsupported length and B the width of flange, both in same units. In general, no beam or girder shall have a greater unsupported length than forty times the width of the compression flange.

Threaded Rods In Tension—One-inch diameter and over, 14,000 lb. per sq.in.; under 1 in. diameter, 11,200 lb. per sq.in.

A. W. A. EDEN,
Engineer, Paterson Bridge Co.

Paterson, N. J., March 1.

NEWS OF THE WEEK

New York, March 23, 1922

Indict Structural Details in Knickerbocker Reports

Associated General Contractors, and American Association of Engineers Make Findings Known

Two of the society committees appointed to investigate the failure of the Knickerbocker Theater in Washington on Jan. 28, have reported, and a third committee has made a report which is not in its final form. The reporting committees are those of the Associated General Contractors and of the American Association of Engineers. The government committee, representing the engineers of the United States Army and Navy, has not yet put in its final report.

Details of the two committee reports will appear in an early issue of *Engineering News-Record*. Meanwhile it may be stated that the Associated General Contractors committee, headed by Rudolph P. Miller, formerly superintendent of the Building Department of New York City, has confirmed the conclusions as to the failure reached by *Engineering News-Record*. The report says "Collapse of the roof was due to weaknesses in the design of the structural steel supporting the roof and of the Columbia Road wall. The direct cause is the unsetting of the north end of the main truss principally through failure of the northernmost top gusset plate of that truss and the bottom chord where it rested on the Columbia Road wall.

Responsibility Placed

Responsibility for these weaknesses is placed upon the architect, who accepted the faulty design from the fabricator; the contractor is not held responsible by reason of the quality of his work or by any non-compliance with the design, specifications and contract, nor for the alternate design, but is held jointly responsible with the building department of the District for failure to apprehend the violations of the building code in detecting that the design did not provide for anchoring trusses to the walls to prevent their slipping from the bearings."

Full recommendations given for preventing a recurrence of the disaster are: (1) Charging sufficient fees for building permits to make possible an adequate force for checking and inspecting new construction; (2) provision by the owner for adequate plans and specifications and inspection on the part of the architect; (3) a revision of building codes standardizing them so that the average architect and contractor may become thoroughly conversant with their requirements; (4) registration of architects, engineers and contractors with the city building department in order to insure adequate skill and responsibility.

The report of the Associated General Contractors committee lists seven principal faults in design, which seem to be in accord with the nine principal faults noted by the report of the committee of the American Association of Engineers, which is headed by N. D. Mitchell. This latter committee, however, holds the contractor jointly responsible with the architect for the alternate design which was faulty. The principal faults noted by the A.A.E. committee are: Support of the main truss on a thin wall lacking solidity and mass; support of the main truss on a skew bearing combined with lack of stiffness in gusset between the end post and lower chord of truss; failure to anchor trusses and heavy beams into the walls; scant bearing at the walls; insufficient section areas and inadequate details of truss members; inadequate column bracing; absence of lateral support of the intermediate panels of the truss T-11; absence of diagonal bracing between the other trusses, and inadequate strength of the roof slab.

Finds Rate on Narrow-Gage Track High

In the complaint of the Lakewood Engineering Co., an I. C. C. examiner recommends that the rates on portable railway track in sections from Cleveland to New York and Baltimore for export are unreasonable because they exceed rates on fish-plates, switches, turntables and crossties.

$40,000,000 Highway Bond Issue for New Jersey

A $40,000,000 highway bond issue was approved by the New Jersey legislature March 17. The bill was passed over the veto of Governor Edwards.

Local Section Am. Soc. C. E. Discusses Theater Failures

At a technical sub-section group conference of the New York Section of the Am. Soc. C. E. held on Mar. 15, the subject for discussion was "The importance of the design of details as evidenced by recent theater failures." Although the conference considered the available evidence with regard to the theaters that failed recently in Washington and in Brooklyn, N. Y., and pointed out defective details of design and construction in these structures, the opinion prevailed that the problem of safe buildings goes far beyond the question of technical details and involves the provision of competent technical supervision from the beginning of design through to the completion of construction. Other conferences on similar subjects will be held by the sub-section in connection with the April and May meetings of the New York Section. James H. Edwards, Asst. Chief Engineer, American Bridge Co., who presided over the March 15 meeting, will be chairman of the April and May conferences.

Port Authority Officials Discuss Harbor Plan

New York Sections of Four National Societies Hear Chairman and Chief Engineer

At a joint meeting of the local sections of the four founder societies, held March 15, at the Engineering Societies' Building, New York City, E. H. Outerbridge, chairman, Port of New York Authority, B. F. Cresson, Jr., chief engineer of that body, and Morris Sherrerd, consulting engineer of Newark, N. J., reviewed the development of the Port Authority and discussed its plan for the organization of the port and its railroad terminal facilities.

Mr. Outerbridge reviewed the conditions and events that led to the formation of the Port Authority and declared its present task to be the adoption of those measures of relief that can be provided by a better and more economical use of existing facilities.

Mr. Cresson summed up briefly the benefits to be derived from closer cooperation between the railroads entering New York and developed at greater length the immediate advantages to be gained by more scientific and business-like handling of Manhattan railroad freight. He urged more team work between the rail service and the trucking service, in order to effect some form of direct delivery between the railroads and the merchants.

Mr. Sherrerd pointed out the advantages to the New Jersey communities that will result from the carrying out of the comprehensive plan of the Port Authority.

Motion pictures were shown in order to visualize the great scope of the Port Authority plan and the economies that will be effected in the handling of the food supply for the 8,000,000 people of the metropolitan port district.

Emergency Food-Distribution Plan

Mr. Outerbridge also described the plans that were laid by the Port Authority to insure a continued supply of food and other necessaries in the face of the threatened railroad strike of last autumn. These plans were based upon the co-ordination of the powers of the two states of New York and New Jersey and of the federal government. It involved the gathering of data as to the stocks and consumption of all supplies in the metropolitan district, the organization of some 200 wholesalers who dealt in necessities, and the provision of a motor-transport system with the necessary supervision of highways in order that the city might draw upon a territory included within a radius of some 200 miles, depending entirely upon the highways and waterways. This skeleton organization, Mr. Outerbridge said, was laid out in about ten days. A headquarters was established, and its various elements were all held in readiness to take up their parts on short notice.

A. R. E. A. Annual Meeting Breaks Records

Previous Meetings Surpassed in Work and Attendance—24 Reports Presented and Acted Upon

Breaking records appears to be a habit with the American Railway Engineering Association, for the attendance at the twenty-third annual convention, held in Chicago, March 14,-16, was again far in excess of previous high mark. The registration (evidently incomplete) showed 707 members and 178 visitors, as compared with 650 and 160 in 1921 and a total of 561 in 1920. Reports of all the 24 committees were presented and acted upon, the work being facilitated as usual by having all reports, with drawings and appendices, printed in advance. This printed matter aggregated about 1,000 pages, exclusive of a reprint of the voluminous report of the American Committee on Electrolysis.

PRESIDENT'S ADDRESS

In a brief opening address the president, L. A. Downs, referred to the movement for closer relations with the engineering schools, for which purpose a special committee has been appointed. Of 15 institutions only 9 per cent of the graduates in civil engineering are working for railroads. And of 350 engineers in railway service only about 50 per cent are graduates. The railways need more of these young men, but to obtain them the managements must offer a more attractive and reasonable wage. The graduate has a financial investment in his training and must capitalize it. But when a fireman is paid $170 a month at the start, a switchman $181, a flagman $141, and a technical graduate only $118, there is something wrong with the wage principle on the railways. Mr. Downs thought that a test of the value of the work of the association is in the use of its reports.

A net membership of 1,948 was shown by the secretary's report. There were 128 new members elected during the year and 16 losses by death. The financial statement was very satisfactory, showing receipts exceeding the high expenditures. Issue of the new *Manual* has been delayed but is expected to be made by June. During the past year the American Railway Association joined membership with the American Engineering Standards Committee and designated a representative of its engineering division (which is identical with the American Railway Engineering Association). This member is E. A. Frink, with J. R. W. Ambrose as alternate.

At a memorial meeting for the late John F. Wallace and Col. Geo. H. Webb, held during one session, brief addresses were made pointing out their high technical attainments, professional accomplishments and personal character. At the annual dinner the three principal addresses were as follows: "Needs of the Railways," R. C. Marshall, Jr., general manager of the Associated General Contractors of America; "The Basis of Patriotism," by Judge James A. Mulligan, of Ottawa, Canada, and "Government and Business," by Dr. Gus M. Dyer, professor of political economy at Vanderbilt University, Nashville, Tenn.

New Jersey Legislature Names New Tunnel Commission

Over the veto of the Governor, the New Jersey Legislature on March 17 passed the bill removing the chairman and certain other members of the Jersey Interstate Bridge and Tunnel Commission and naming new commissioners to take their places. T. Albeus Adams is ousted as chairman, together with Samuel Shay, Charles S. Stevens and Frank F. Gallagher. The New Jersey commission had been unable to agree with the New York commission on many important matters of administrative policy with the result that, except for the construction of ventilating shafts on the New York side of the Hudson, progress has been halted for practically a year.

With the advent of the new commission, headed by Theodore Boettger and the other candidates named in the news section of this journal March 16, p. 460, it is expected that the contract for constructing the twin tubes under the river, for which Booth & Flinn, Inc., were low bidders at last month's opening of bids, will be awarded.

Another tangle of long standing which was straightened out was the reinstatement of the board of consulting engineers which was summarily "dismissed" April 26, 1921, by the Jersey commission without concurrent action by the New York commission. At the same time the newly organized Jersey commission, at its meeting March 21, passed a resolution nullifying, on grounds of illegality, the appointment on May 10, 1921, of St. John Clarke and George M. Wells as "technical advisers" to supersede the consulting board. The Jersey commission further ordered the return and cancellation of the pay vouchers covering the salary of Mr. Clarke and Mr. Wells since last May which had been forwarded to Trenton by the old commission just before it was legislated out of existence. No money had ever been paid by the Jersey commission to Messrs. Clarke and Wells and the present action leaves these engineers without means of recovery unless they resort to legal proceedings.

The board of consulting engineers which now resumes its former status consists of Col. W. J. Wilgus, Major John A. Bensel, Prof. William H. Burr, E. A. Byrne, J. Vipond Davies, and Col. George L. Watson.

Officers elected for the year 1922-23 are as follows: President, James L. Campbell, chief engineer, El Paso Southwestern R.R.; vice presidents, E. H. Lee, vice president and chief engineer, Chicago & Western Indiana R.R., and G. J. Ray, chief engineer, Delaware, Lackawanna & Western R.R. The former holds over from 1921. Five new directors, including three regulars and two to fill vacancies in the list of nine directors, are: D. J. Brumley, chief engineer of Chicago terminal improvements, Illinois Central R.R.; Maurice Coburn, engineer of maintenance of way, Pennsylvania System; H. T. Douglas, Jr., chief engineer, Chicago & Alton R.R.; C. E. Lindsay, special engineer, New York Central Lines, and W. P. Wiltsee, assistant engineer, Norfolk & Western Ry treasurer, G. H. Bremner; secretary, E. H. Fritch.

Hearings Begun on New Road Legislation

Markham, Representing State Highway Officials Urges $75,000,000 for Three Years

(*Washington Correspondence*)

Active work on highway legislation to become effective July 1, has started in the House of Representatives. Public hearings began March 15 before the Committee on Roads. It seems probable that the committee will recommend the plan contained in a bill, introduced by Representative Woodruff, of Michigan, providing an appropriation of $50,000,000 for the next fiscal year, $65,000,000 for the fiscal to end June 30, 1924, and $75,000,000 for the fiscal year to end June 30, 1925. W. C. Markham, representing the American Association of State Highway Officials, appeared before the committee and contended for appropriations of not less than $75,000,000 for each of the next three fiscal years.

The Woodruff bill, which seems to have the support of a majority of the House committee, provides in addition that not to exceed 3 per cent of the federal-aid appropriation may be expended for administering the act or for carrying on research and investigational studies. The bill also carries an appropriation of $6 500,000 for roads and trails in the national forests during the fiscal year to end June 30, 1924, and $7,500,000 for the fiscal year to end June 30, 1925.

MARKHAM'S ARGUMENT.

The more important points made by Mr. Markham on the occasion of his appearance before the committee may be summed up as follows:

"Approximately, the first 7 per cent system of the highways of this country [as provided for in the Federal Highway Act] is 186,700 miles. Of this mileage 69,090 miles have been improved or are in various stages of construction. That portion of this constructed mileage which has been paid for by the use of federal aid has been done at an average cost of $18,000 per mile. The federal government has contributed 42½ per cent and the states 57½ per cent. This leaves 117,610 of the first 7-per cent system to be built. Presuming that this mileage will be constructed at the same average cost as heretofore and that the federal government and the states will pay the cost in the same ratio, the time required to carry out this plan will be as follows: If you make an appropriation of $100,000,000 per year, it will take 10 years, an appropriation of $75,000,000 per year will take 15 years, and an appropriation of $50,000,000 will require 20 years to complete the system.

"To show you that this calculation is very liberal towards the completion of the work it should be borne in mind that no lag in completion of this system is allowed for reconstruction or surfacing of any part of the 69,090 miles now improved, although a part of this mileage will undoubtedly need a higher type of construction due to the increased traffic requirements.

"Representing the States, which through their State Highway Departments, are responsible for co-operation

(Continued on p. 505)

France to Give Up State Railways

After fourteen years of government operation at heavy loss the French Government is now preparing to turn over the Etat railway system to a private corporation. A plan to embody this course, which has been decided on by a parliamentary commission, will soon be laid before the Chamber with the approval of the government.

Appropriation for Roads Bureau

In reporting to the House the agricultural appropriation bill the House Appropriations Committee recommends $483,320 for the U. S. Bureau of Public Roads for next year, which is $14,800 in excess of current appropriations but $19,700 less than the estimates.

Pittsburgh Highway Tunnel Holed Through

The west tube of the Liberty twin tunnels in Pittsburgh, Pa., was holed through March 11. When the two crews met in approximately the center of the tunnel it was found that there was a variation of but ⅜ in. in line. A record of 12 ft. a day excavation and finished concrete lining has been attained. Three hundred and eighty-eight working days have been recorded on the tunnel construction to date and an average of 200 men per day have been employed. Approximately 300,000 cu.yd. of rock and earth have been moved to date. Details regarding the design and construction of these tunnels may be found in *Engineering News-Record*, Sept. 22, 1921, p. 478.

Move To Standardize Road-Material Specifications

Highway officials from Pennsylvania, New Jersey, Delaware, Maryland, Virginia, West Virginia, and Kentucky will meet with officials of the U. S. Bureau of Public Roads in Washington, March 23, to make such standardization of specification as will result in economy in construction in these States. The aim is to revise the specifications in such a manner that material from the same source may be used in all the states without difficulty.

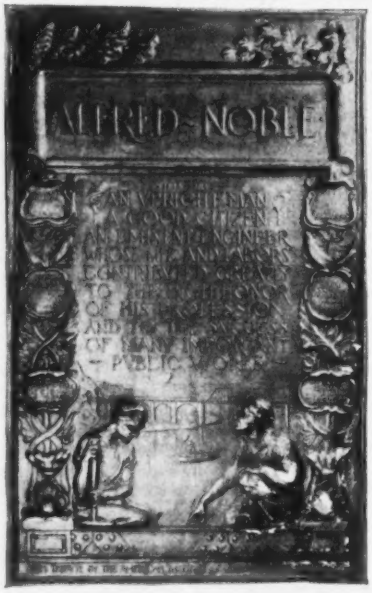
At present a stone, gravel or sand plant may be supplying road jobs in two or three states. Due to variations in specifications the same sizes of material cannot be used on the different jobs for identical classes of work. The plant must use different screens and bins in supplying each job and the result is an increase in cost without a corresponding increase in the quality of the work.

Similar meetings will be held immediately between officials of the bureau and other groups of states with the same object in view. The movement has been initiated by the American Association of State Highway officials and is being worked out in groups of states so as to take into account conditions existing in each group. A committee composed of bureau and state highway bridge engineers has been working for some time on the standardization of bridge specifications.

Officials of the bureau say that since highway construction has grown to be one of the biggest industries in the country it must be organized and conducted with the efficiency characteristic of big business.

Unveil Bronze Tablet as Memorial to Alfred Noble

As a memorial to Alfred Noble in recognition of his distinguished achievements in the field of engineering, a bronze tablet, the gift of the American Institute of Consulting Engineers, was unveiled March 15 in the Engineering Societies' Building, New York. Charles W. Leavitt, consulting engineer, made the address of presentation and J. Vipond Davies, consulting engineer, accepted the memorial in behalf of the



ALFRED NOBLE MEMORIAL TABLET

United Engineering Society. The tablet, which has been placed on the wall to the left of the main entrance to the Engineering Societies' Building, was designed by Willard D. Pollock, New York sculptor.

The upper portion of the bronze carries the following inscription:

ALFRED NOBLE
1844-1914

An Upright Man, a Good Citizen, an Eminent Engineer Whose Life and Labors Contributed Greatly to the High Honor of His Profession and to the Success of Many Important Public Works. This Tribute by the American Institute of Consulting Engineers, 1922

Below the inscription there is shown, in relief, a river spanned by a bridge and in the central foreground two figures of structural workers. In decorative panels at each side of the tablet are references to the more important engineering works with which Mr. Noble was associated, including the East River tunnels of the Pennsylvania R.R., New York, the Nicaragua Canal Commission, the locks at Sault Ste. Marie, the Catskill Adqueduct, the Pearl Harbor dry dock in Hawaii, the Isthmian Canal Commission, and the Washington, Memphis and Cairo bridges.

Last week's ceremonies mark the first instance of the presentation of a memorial by an engineering society to one of its own members.

The meeting was attended by about thirty engineers including Allen Hazen, Col. W. J. Wilgus, George W. Fuller, J. Waldo Smith, Frank J. Sprague, Dr. Alexander C. Humphreys and Alfred D. Flinn.

Four Indicted as Result of Brooklyn Theater Failure

Manslaughter in First and Second Degrees Charged Against Each—Magistrate's Findings

Four persons were indicted March 18 as a result of evidence laid before the grand jury concerning the collapse of the American Theater in Brooklyn, N. Y., last November, which resulted in the death of seven men. Two indictments charging manslaughter in the first and second degrees were returned against each individual. The four men indicted are Joseph Gaydica, who furnished the steel for the structure; James M. Finlay, an inspector of the Building Department of the Borough of Brooklyn who had charge of the steelwork inspection; James Kavanaugh, the contractor who erected the steel for the building, and Samuel Moskowitz, one of the owners and builders of the theater. All four defendants were arraigned in the county court and entered pleas of not guilty. Bail was fixed at $10,000 in each case.

Chief Justice William McAdoo, before whom the Kings County district attorney has been conducting a John Doe investigation into the collapse of the theater, denounced the custom of "slip-shod, haphazard inspection" that was imputed to have been allowed in the Brooklyn Department of Buildings. The magistrate's findings of fact after a review of the situation included:

"There was no architect in charge of the work; there was no competent supervisor; there was no responsible engineer; there was no approved plan for the steelwork; and there was no official permit allowing its erection."

FINDINGS OF MAGISTRATE

Three things, the magistrates found, the builders had in mind: "to get the building as cheaply constructed as possible, to have an auditorium that would hold the largest number of people, and to hasten the time when they would be able to open the theater." The essential points in Magistrate McAdoo's review were that "a set of plans for the steel construction were drawn and approved by the Bureau of Buildings in the summer of 1921. The owners awarded the contract to the Gaydica Iron Works to furnish and put up the trusses and girders on which the roof was to rest. Subsequently, Gaydica, through his own engineer, filed an amendment to the original plan for the structural steel. These plans were filed Sept. 19. When they reached the official examiner attached to the Department of Buildings he made twenty-one objections and wrote out the same and attached them to the official papers. With these objections filed, the Gaydica plans were not approved until Nov. 2, 1921.

"In the meantime Gaydica furnished a working plan which he gave to Pluckham & Kavanaugh, the firm who had contracted to do the work of the erection of the steel structure to sustain the roof. Kavanaugh, a working erector of the firm, was the active man in control of the work. He followed the plan given him by Gaydica. This plan was never passed upon nor approved by the Building Department and differed from both the Kleinert plan (the plan that had been approved) and the plan subsequently approved as the Gaydica plan."

A. A. E. to Hold Annual Convention at Salt Lake City

The American Association of Engineers will hold its eighth annual convention at Salt Lake City, Utah, June 5-7. According to the tentative program just announced, the sessions on June 5 will be devoted to reports of officers and standing and special committees. At the morning meeting, June 6, the topic for discussion will be "Policies of Employment, Education and Other Departmental Service," while the afternoon will be given over to a chapter symposium. Amendments to the constitution and by-laws will be considered on the morning of June 7, while the remainder of that day will be occupied by a sight-seeing tour and the annual banquet.

Ball Engine Co. Changes Its Name

Because of the change in the character of its product from engines for power plant use to steam shovels and cranes, the Ball Engine Co. has changed its name to the Erie Steam Shovel Co. The company practically ceased the manufacture of engines about two years ago. Now it has sold its engine business. There has been no change in the personnel, assets or policies of the company since it has assumed a name more in keeping with its present activities. In six years the company has tripled its plant capacity to meet the demand for shovels and cranes.

Fire Protection Association at Atlantic City

The twenty-sixth annual meeting of the National Fire Protection Association will be held at Atlantic City, N. J., May 9-11, with headquarters at Chalfonte-Haddon Hall. The program for the meeting will be announced later. The secretary of the association is Franklin H. Wentworth, 87 Milk St., Boston, Mass.

Cleveland Gets Municipal Improvements Convention

The American Society for Municipal Improvements will hold its next annual convention at Cleveland, Oct. 9-13, according to an announcement made last week by Charles Carroll Brown, P. O. Box 34, St. Petersburg, Fla., secretary of the society.

Road Hearings Begun

(*Continued from p. 503*)

with the Federal government in this work, we are not disposed to ask the Congress for larger appropriations than can, recognizing economic conditions as well as traffic needs, be absorbed each year properly safeguarded in every particular. To this end, I wish to state that investigation shows that while a very few states, because of varied and peculiar conditions will need the next fiscal year to absorb the appropriations already made, two-thirds of the states can readily absorb all of their apportionment of a $100,000,000 appropriation. To cut this appropriation by two would mean to retard the work in many states to an extent that, in our judgment, would be an economic mistake. We therefore recommend that the Federal appropriation for the fiscal year 1922-23 should be $75,000,000.

Hydraulic Prime-Mover Makers Merge Interests

The plant and interests of the Pelton Water Wheel Co., San Francisco and New York, have been acquired by the William Cramp & Sons Ship & Engine Bldg. Co., Philadelphia. The Pelton Water Wheel Co. will continue under the old corporate name, but will be newly officered by H. B. Taylor (vice-president of the Cramp company), president; Ely C. Hutchinson (formerly chief engineer of the Pelton company), vice-president and general manager; William M. Moody, second vice-president.

This development combines two of the oldest companies in the United States manufacturing hydraulic prime movers. The I. P. Morris department of the William Cramp & Sons Ship & Engine Bldg. Co. is widely known as the builder of large reaction turbines. Among these are those of the Queenston-Chippawa development on the Canadian side of the Niagara Falls, having a capacity of 55,000 hp. each. The Pelton leads in high-head or impluse-wheel practice.

Morris Canal Abandonment Bill Approved by Governor

A bill naming a commission of three, with legislative powers, to negotiate with the owners of the Morris Canal for its abandonment has become a law. The commissioners are W. H. Spear, Judge of the U. S. Circuit Court, Jersey City; Frank H. Sommer, Newark; and Louis A. Focht, chief engineer of the State Board of Taxes and Assessments, Trenton. The canal extends from the Delaware River to tidewater in Jersey City. It was built under a charter granted in 1824 to the Morris Canal & Banking Co. In 1871 the property was leased to the Lehigh Valley Railroad Co.

For decades past, the water rights held and claimed under this charter have entered into the history of the water supply of Newark, Jersey City, Paterson and other municipalities in the New Jersey metropolitan district that have had or now have contractual relations with the East Jersey Water Co. and allied water companies and interests. (For an editorial review of this subject down to 1895, see *Engineering News*, April 25, 1895, p. 273; see also *Engineering News-Record*, March 16, 1922, p. 430, for a lengthy abstract of a report by Hazen, Whipple & Fuller on possible additional water supplies for the New Jersey district in question).

Reject Proposal to Use Ships' Hulls for Bridge

Rejection of the proposal to bridge Lake Washington by means of utilizing fifteen wooden hulls from the U. S. Shipping Board craft moored in Lake Union, has been announced by the King County (Washington) Commissioners, who refused to forward to the U. S. Shipping Board a bid for $1,500 for the hulls. This sum had been raised by business men and residents of Mercer Island, who are interested in the furthering of the project. The commissioners declared that construction of roads costing $575,000 would be necessary to open the bridge to travel, and that the annual upkeep would be $50 000 a year, with the life of the bridge a doubtful question.

Middle West Puts Up Candidate for Am. Soc. C. E. Presidency

The Illinois Section of the American Society of Civil Engineers has called a special meeting in Chicago, March 24, to consider the candidacy of Charles F. Loweth, chief engineer, Chicago, Milwaukee & St. Paul Ry., for president of the parent organization. The notice sent out states that it is time that the presidency be brought west and 150 members now favor Mr. Loweth.

Favors Paving Guaranty

John L. Elliott, city engineer of Indianapolis, has sent a letter to the Board of Public Works, advising that no steps be taken to eliminate from the specifications for permanently improved streets, the provision requiring the contractor to put up a maintenance guaranty. He said the elimination of this guaranty would cause trouble for the city in obtaining proper repair of streets. There has been no open discussion before the board of works of any plan of eliminating the guaranty provision from the street specifications, but the suggestion was made to the board that lower bids might be obtained on asphalt street contracts were the provision eliminated.

Fight To Lower Asphalt Prices in Indianapolis

A fight upon high prices of asphalt pavement in Indianapolis was begun by John L. Elliott, city engineer, who, in a letter to the Board of Public Works, recommended the rejection of several bids and urged that out-of-town contractors be invited to bid upon future work. The board had the letter read to about fifty contractors who were present at the opening of bids on a number of street and sidewalk improvements

Mr. Elliott presented a table showing, according to U. S. Labor Bureau figures, that the price of 200 commodities is only 48 per cent higher now than in 1915, while the price of asphalt paving as contained in bids of local contractors, is 125 per cent higher than in 1915. The board took under advisement Mr. Elliott's recommendation that proposed street improvements be held up until a square yardage of 50,000 accumulates so as to make it profitable for outside contractors to come into the field.

Steam Power Plant at St. Louis To Cost $6,000,000

Negotiations have been completed for the construction south of the city limits of East St. Louis, Mo., of a new steam power plant to cost $6,000,000. L. H. Egan, president of the Union Electric Light & Power Co. of St. Louis, has taken title to about 50 acres of land as a site for the plant and McClellan & Junkersfeld, Inc., of New York City, have been engaged as engineers and constructors.

The plant will supply the rapidly-increasing demand for electrical energy in St. Louis and vicinity. It will be named the Cahokia steam power plant and will have an initial capacity of 60,000 kw. and an ultimate capacity of probably 240,000 kw. The first two units will be of 30,000 kw. each, supplied with steam at 300 lb. pressure at the throttle and will deliver electrical energy at 50 cycles, 13,200 volts.

Hoover Favors Construction of Boulder Canyon Dam

Opinion Given After Hearings at Washington, Phoenix and Los Angeles

(Special to Engineering News-Record)

Secretary of Commerce Herbert Hoover, acting as chairman of the Colorado River Commission, has definitely committed himself as favorable to the immediate construction of the Boulder Canyon dam by the Federal Government and under government engineers in accordance with the plans proposed by A. P. Davis, director, U. S. Reclamation Service. This expression of his views followed hearings at Phoenix, Ariz., March 15-18, and at Los Angeles, Cal., March 20.

The Colorado River Commission was created by Congress to formulate an agreement or compact under which the distribution of the waters of the Colorado River could be made between the seven states lying wholly or in part within the drainage basin. The first hearing of the commission, held Jan. 26, in Washington, D. C. (see *Engineering News-Record*, Feb. 9, p. 255), lasted two weeks and reached no definite conclusions. The second hearing, at Phoenix, was given over largely to the presentation of the views of Arizona interests. Representatives from Southern California, including the Imperial Valley, presented a resolution urging the immediate construction of the Boulder Canyon dam as a flood-control measure pending the making by the commission of a permanent compact among the seven states, not without prejudice to the right of any state. The third hearing was held in Los Angeles, Cal. March 20.

Secretary Hoover announced that presentations to the commission should be confined to suggestions for the terms and form of compact to be entered into by the seven states. Presentations were made by Director Davis of the Reclamation Service relative to an adjustment of the sharply conflicting interests between the upper and lower basins over water rights growing out of the proposed developments.

Construction Industries Announce Convention Program

A three-days' program, with two days devoted to addresses and discussions, is planned by the National Federation of Construction Industries for the construction conference to be held in Chicago, April 3-5.

One session only will be held on the opening day, the address being: "How Trade Associations Can Be Made More Effective." On the second day the subjects for papers and discussions are: "Capital Must Be Economically Mobilized for Construction"; "Can Cost of Financing Construction be Further Reduced?" "Efficient Workers Needed to Meet Country's Construction Program" and "Handicaps to Reducing Construction Costs." On the last day some ten formal discussions are planned, on elimination of waste and better design, distribution, production, transportation and utilization of materials.

The convention proceedings will close with a banquet on the evening of April 5 and several luncheons and dinners are listed for the preceding days. The meetings will be held at the Drake Hotel.

Commerce Dept. Seeks Statistics from Trade Associations

The Secretary of Commerce will hold a conference in Washington with representatives of trade associations the activities of which are national or interstate in their scope, in Room 704, Department of Commerce Building, on April 12, at 10 a.m., for the following purposes:

1. Securing a list of trade associations that will furnish voluntarily to the Department of Commerce the classes of statistical information outlined in the correspondence between the Department of Commerce and the Department of Justice (See issue of Feb. 16, p. 294).

2. Discussing and considering means and methods that may be best adapted for collecting and forwarding to the Secretary of Commerce, for dissemination, the classes of statistical information outlined in the correspondence referred to.

3. Discussion of the manner in which such reports of the statistical officer of the associations are to be filed with the Department of Commerce, and the manner and method of distributing the information therein.

A. F. L. To Promote Reclamation and Mississippi Improvement

President Gompers of the American Federation of Labor has announced that bills for land reclamation and for Mississippi River improvement are to be drafted and introduced in Congress as the result of studies by a special committee of the A. F. of L. Joint Legislative Conference, composed of some forty representatives of labor. The reclamation bill will have as its main feature the development of the Colorado River for irrigation, but minor projects would be included. Mississippi River improvement would be designed to promote navigation throughout the entire river system, besides preventing floods, reclaiming land for agriculture, and preventing disease apparently by lessening mosquito breeding. Government bonds to finance these projects are proposed by the Committee already named, which includes, among others, C. M. Rosemund, president, International Federation of Technical Engineers, Architects and Draftsmen's Unions.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Spring Society Meeting, Dayton, Ohio, April 5-6; Subject, "Flood Problems."

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 9-11.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Philadelphia, May 15-19.

The Connecticut Society of Civil Engineers at its recent annual meeting elected the following officers: President, Robert J. Ross, Hartford; first vice-president, Alfred H. Terry, former city engineer, Bridgeport; second vice-president, Clarence M. Blair, New Haven, secretary-treasurer, Henry J. Kellogg, New Haven.

The Pueblo (Col.) Engineers' Association at the recent annual meeting elected the following officers: President, H. K. Burton; vice president, D. J. Cox; secretary-treasurer, W. B. Curry. "Flood Prevention" and "Cheaper Power for Colorado" were discussed.

The Lincoln (Neb.) Chapter A. A. E. will have as its principal speaker at the meeting to be held April 10, Edwin S. Jarrett of Jarrett & Chambers, foundation engineers and designers of the foundations of the capitol building to be erected in Lincoln the coming year. This meeting will be a joint meeting of the Lincoln chapter of the A. A. E., the Nebraska chapter of the Am. Soc. C. E. and the student chapters of both organizations at the University of Nebraska.

The London, Ontario, Branch of the **Engineering Institute of Canada** at its annual meeting elected the following officers: Honorary chairman, J. Davis Barnett; chairman, Harry Brazier; vice-chairman, J. Forbes Mitchell; secretary-treasurer, George C. Wright.

The North Dakota Society of Engineers held its annual meeting at Jamestown, Feb. 8 and 9. The opening session was given over to a discussion of licensing. A series of professional sessions occupied the balance of the time, and at the business meeting which closed the activities E. R. Griffin of Mandan, N. D., was elected president.

The American Water Works Association will hold its forty-second annual convention in Philadelphia, May 15-19. J. M. Diven, 153 W. 71st St., New York City, is secretary.

Personal Notes

WILLIAM H. RHODES, Jr., who has been senior highway engineer, U.S. Bureau of Public Roads, has accepted the position of maintenance engineer with the Louisiana Highway Commission.

G. C. OMMANEY has been appointed development engineer of the Development Branch, Canadian Pacific R.R., department of colonization, with headquarters at Montreal. Mr. Ommaney has been with the C.P.R. since 1907.

FRANK C. LINGENFELTER, Indianapolis, formerly city civil engineer, has opened an office as a consulting engineer.

A. F. HARLEY has been appointed highway engineer for the Cocoa Beach special road and bridge district, and has opened an office at Cocoa, Florida.

THOMAS C. NORTH, borough engineer of DuBois, Penn., has been elected borough engineer and borough manager of Blairsville, Penn.

D. A. YOUNG, who had been with the New York State Highway Department since 1909, was recently appointed state engineer of Vermont.

JOSEPH JACOBS, of Seattle, has been appointed consulting engineer of the department of conservation and

development on plans for the greater Wenatchee and Quincy project. This project was recently surveyed by the state and involves the irrigation from Lake Wenatchee of about 50,000 acres in the Greater Wenatchee district and nearly 100,000 acres in the Quincy section. The districts are financing the investigation and development of the project.

W. C. BUETOW has been made bridge engineer of the Wisconsin Highway Commission succeeding M. W. TORKELSON. He has served with the commission in various capacities since 1911. At the time of his appointment as bridge engineer he held the title of assistant engineer, in charge of the day labor and material division. He is a graduate of the University of Wisconsin.

BUSINESS NOTES

ROBERT M. GATES, formerly a partner of the Herron Gates Co., Cleveland, Ohio, has become associated with Superheater Co., N. Y., handling power-plant equipment.

L. H. HART, formerly with the National Lime Association, has organized the L. H. Hart Building Lime Service, Buffalo, N. Y., which undertakes the solution of various problems concerned with the uses of lime.

D. B. FRISBIE of Atlanta, Ga., has been assigned the responsibility of developing a large selling organization throughout the south for the Barber-Greene Co., of Aurora, Ill. So far ten sales organizations have been put under his direction.

THE RITER-CONLEY CO., a Pennsylvania corporation, recently filed papers with the secretary of state at Indianapolis, qualifying them to do business in Indiana. The company was organized for the construction, erection and equipment of all buildings. Willard B. Van Horne will be the Indiana agent.

THE FOSTER ENGINEERING SERVICE CO. was recently organized at Indianapolis, Ind., for general engineering and construction work. C. B. Foster, T. A. Lavelle, T. D. McGee and W. B. Stern are directors of the company.

THE FEDERAL ROAD BUILDERS' MANUFACTURING CO. has been organized at Indianapolis for the erection of steel and concrete bridges, viaducts, etc. Leo Traugott, Louis Traugott and A. Joseph are directors of the company.

FRANK J. MCHUGH and G. A. FERGUSON of Seattle have consolidated under the name of the McHugh Construction Co. Officers of the company are Frank J. McHugh, President; P. J. McHugh, vice-president; and G. A. Ferguson, secretary-treasurer. Frank J. McHugh and Mr. Ferguson have each been in the road contracting business in Washington for more than 15 years.

WILLIAM J. CLEARY, recently general purchasing agent of the Willys Corp., with headquarters in Elizabeth, N. J., has been made assistant general sales manager of the Sharon Pressed Steel Co., with headquarters in Detroit, Mich. His new duties will cover the automotive industry in general.

OBITUARY

EDGAR T. WHEELER, manager of the Edgar T. Wheeler Co., contractors and engineers of Los Angeles, Cal., died recently at his home in Los Angeles.

JOHN H. FELTHAUSEN, chief engineer of S. Morgan Smith Co., York, Pa., died at his home in New York, March 5.

WILLIAM M. PHILLIPS, who supervised the construction of the New York Shipbuilding Corp. plant in Camden, N. J., died recently at his home in Torresdale, Penn. He was in charge of clearing up the wreckage of the Johnstown flood, and served for many years in the engineering department of the Pennsylvania R.R.

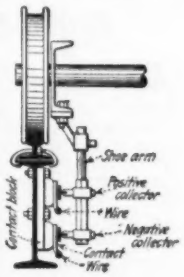
CHARLES R. ROCKWOOD, for more than thirty years identified with engineering construction in the West, died at his home in Los Angeles on March 4. Mr Rockwood was born in Michigan in 1860. He entered the University of Michigan but left in 1882 before finishing his course to go to California. His first work in California was with the engineering department of the Southern Pacific R.R. In 1889 he was employed by the U. S. Geological Survey. Subsequently he was in Oregon for some time on irrigation development and later went to the Imperial Valley. His leadership in the great Imperial Valley irrigation project, while it was still in the formative period, led to his becoming known as the "father of the valley" and he was the original of the character portrayed as Seer in Harold Bell Wright's book on the valley, "The Winning of Barbara Worth." Mr. Rockwood was the general manager and chief engineer of the California Development Co. (the predecessor of the present Imperial Irrigation District) from December 1914 to December 1916.

EQUIPMENT AND MATERIALS

Traveling Crane with Surface-Contact Collector

An electric surface-contact system for operating overhead traveling cranes, thus giving protected live spots instead of a bare trolley wire or third-rail conductor is being introduced by the Simplex Surface Contact System, Williamsport, Pa. In a recent installation a collector shoe 11 ft. long is carried by the crane and slides over insulated copper-faced contact blocks spaced 10 ft. apart and attached to the web of the runway girder. Spring pressure exerted by the shoe presses on the cap of the block, making electric connection between the feed wire and the controller on the crane. The length of the collector shoe is such that before it leaves one block, it has engaged the next one.

For the feed and return wire circuits, the blocks are so made that the two insulator contact points are mounted on a single base which is bolted to the girder. The contacts are separately connected to their respective wires. The two shoes are also mounted on a single support and placed one above the other, as shown. These shoes are adjustable and are so constructed as to be easily bolted to the crane carriage. Only the face of the shoe is alive, as an insulating strip extends the entire length of the shoe and insulates the contact face from every other part. Copper contact of the fixed block has a surface of 2½ in. high and 1¼ in. wide. The lower end is bent into a loop to support the feed wire, the insulation of which is removed at this point to permit the soldering of the wire to the copper strip.



Pressed-Lead Roofing

A lead sheet for roofing has been developed by the United Lead Co., New York, N. Y. The metal used is the "hardlead," which has been long used for downspouts, flashing, cornices, etc., and it is pressed into the form required for roofing.

Pressed roofing is made in flat sheets 24 x 24 x 3/32 in. Each square contains nine shingles. It is applied directly to the roof slope without any mechanical preparation. The squares are laid diagonally on the slopes and secured by clips at the upper edges leaving free movement for each sheet. Each sheet interlocks with the adjoining ones and forms a complete waterproof joint. No soldering is necessary. Starting sheets have a lip to fit over the eaves board.

Sensitized Tracing Cloth

The New York Blue Print Paper Co. has put upon the market sensitized tracing cloth, by means of which reproductions of tracings may be easily made. The process involves making a negative with brown-print paper from which the tracings are reproduced upon the sensitized cloth, which, after proper exposure, is put into a bath and then a developer. After drying a lacquer coat is applied. The reproductions of original tracings are waterproof.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Rapid-Fire Survey of Business Conditions

"Suspended purchasing power," is what William T. Foster, in the Mar. 13 *Annalist*, calls money. He writes: "The owner of money, as the holder of such a convenient store of suspended purchasing power, virtually controls the production schedules of the world; and, in the very process of exercising this control—the spending of his money—he determines for the most part the prices at which goods are sold. For this reason, studies of the ups and downs of business may well begin with the changes in the volume and distribution of purchasing power relative to changes in available goods, and changes in the mental attitudes of the holders of purchasing power."

Money stocks in the United States on Mar. 1 are compared with stocks on Feb. 1, by the Treasury Department, as follows:

Total	decreased	$3,002,692
Gold	increased	39,873,254
Silver dollars	increased	2,920,000
Federal Reserve notes	decreased	42,444,150

Changes during the twelve months ended Mar. 1 were as follows:

Total	decreased	$8,713,031
Gold	increased	803,870,885
Silver dollars	increased	90,599,525
Federal Reserve notes	decreased	826,680,535

The highest point ever reached by the total stock of money was $8,372,959,004 on Jan. 1, 1921. The lowest last year was $7,942,675,633 on May 1. The present stock of gold is the highest ever reached in this country; the lowest last year was $2,784,834,427; the lowest since the war, $2,646,615,750, on May 1, 1920. In the armistice month the country's stock of gold was $3,079,784,766.

Japan's national wealth amounts to 86,077,000,000 yen, against 32,043,000,000 before the war, according to a report to the League of Nations. The yen has an exchange value of 47.375 cents; par is 49.8 cents.

French bank note circulation is 35,640,367,000 francs, against 38,245,393,370 francs one year ago. The highest point was 39,645,896,000 on Nov. 3, 1920.

Exports in February amounted to $251,000,000, a decrease of $28,000,000 from January. This is the lowest since August, 1915. Imports were valued at $217,000,000, which is an increase of $1,000,000 over January.

Wholesale prices advanced 3 points in February, Labor Statistics' index number for all commodities being 151, and 167 one year ago. The increase was most pronounced among farm products and foodstuffs.

Retail food prices were about the same in February as in January, 42 per cent higher than in 1913.

Highest priced commodities of fifty listed by the Harvard Economic Service, with their percentage increase over 1913 prices, are: tobacco, 225 per cent; brick and cotton-goods, 130; anthracite coal, 109; serge, 94; alcohol, 91; worsted yarn, 90. By groups the figures are as follows: grains and flour, 24; live stock, meats, hides and leather, 1; metals and metal products, 8; fibers and textiles, 71; fuels, 51; building materials, 59; miscellaneous, 41.

Steel production is at the rate of 29,000,000 gross tons of ingots a year, which is 25 per cent above the rate in October and November, and 15 per cent above the rate in 1910—the best year prior to 1912. In considering the current satisfactory demand for steel it must be borne in mind that an appreciable proportion is to replenish stocks rather than for immediate consumption.

Employees in 109 iron and steel establishments reporting to the Department of Labor numbered 124,932 in February, against 144,679 one year ago, and the payrolls were $5,306,863 and $9,393,391, respectively. But there was a gain in February over January, 1922, or 9.3 per cent in numbers of men and 15.7 in amount of payroll. Twelve mills reported wage cuts, but the per capita earnings of all the workers were 5.9 per cent higher than for January.

Freight loaded in the week ending Mar. 4 amounted to 803,255 cars, the record since November, 1921. All commodities except forest products show an increase over the preceding week. The principal increase is in merchandise, L.C.L., which shows a gain of 32,276 cars.

Surplus cars continue to decrease in number, the figures for Mar. 8 being 88,974 box, 86,464 coal and 223,846 all freight cars, representing reductions since the week before of 6,387 box, 11,170 coal and 21,254 total.

Earnings of Well-Known Companies in 1921 and 1920

The annual financial statements of several well-known American business organizations, as reported to the press, show an unusually large number of net losses, for the year 1921, suffered by certain companies as compared with substantial net gains realized by others. Despite the abnormal conditions under which these organizations have been operating during the past year the outlook for 1922, as depicted by various prominent officials, is very reassuring.

A. R. Erskine, president of the Studebaker Corporation, in addressing the stockholders, said: "The Management believes that business this year will show a substantial increase over that of last year."

George J. Baldwin, president of the Pacific Mail Steamship Co., speaking to the stockholders, made the following statement: "The year 1921 was a period of adjustment. Revenues decreased in marked degree, with reductions in expenses failing to keep pace with falling returns."

Charles A. Stone, president of the American International Corporation, in his remarks to stockholders said: "Toward the close of 1921 there was good reason to believe that the worst of the world depression had been seen. While no one will venture to predict the precise degree of improvement that may be expected this year there is warrant for believing that a process of recovery has begun."

Judge Gary stated that "the average production for the entire year (1921) in rolled and other finished products was 47.5 per cent, the lowest in any year since the organization of the corporation."

Following are net earnings or losses of well-known companies:

Company	Net Earnings or Losses (Deficits shown in italics) — Total — 1921	1920	Per Share, Com. 1921	1920
Alpha Portland Cement Co.	†$672,338	.....	.....	.....
American International Corp.	184,681	1,783,466	.....	.....
American Steel Foundries Co.	675,009	4,496,442	0.13	6.37
American Surety Co.	1,022,295	600,000	20.00	12.00
American Telephone and Telegraph Company	54,002,703	51,821,215	11.10	11.70
American Tobacco Company	18,615,398	15,151,155	16.84	13.38
Bucyrus Company	145,905	530,984	.....	.....
Columbia Gas Company	4,303,536	4,839,377	8.60	9.68
Corn Products Refining Company	6,326,358	12,469,626	9.21	21.53
Cumberland Telephone and Telegraph Company	*17,135*	145,589	.....	.....
Fisk Rubber Company	3,336,467	.....	.....	.....
General Motors Corporation	*38,680,770*	37,750,375	.....	1.56
Gulf States Steel Company	*591,915*	751,220	.....	.....
Interborough Rapid Transit Company	*4,464,826*	*2,236,835*	.....	.....
International Motor Truck Corporation	126,931	2,644,013	.....	.....
Lehigh Coal & Navigation Company	5,394,224	.....	.....	.....
Middle States Oil Company	6,293,891	6,964,020	4.26	.....
New York Telephone Company	13,244,543	6,070,013	8.29	4.04
New York Air Brake Company	*458,899*	751,860	.....	7.51
Otis Steel Company	*5,189,543*	1,141,088	.....	1.48
Pacific Mail Steamship Company	*495,591*	*1,622,470	.....	.....
Penn Seaboard Steel Corporation	*749,045*	*768,247*	.....	.....
Pierce-Arrow Motor Car Company	*8,763,712*	1,769,915	.....	.....
Pittsburgh Coal Company	*1,197,937*	.....	.....	.....
Pyrene Manufacturing Company	64,574	.....	.....	.....
Solar Refining Company	*503,648*	698,207	.....	.....
Southern Bell Telephone and Telegraph Company	720,168	803,240	2.40	2.67
Standard Oil Company of Ind.	21,288,348	40,973,484	4.95	11.63
Studebaker Corporation	9,723,691	9,111,904	16.20	15.20
Texas Oil Company	9,286,129	31,089,372	1.41	5.98
United States Gypsum Company	2,247,326	2,126,778	6.48	6.52
U. S. Cast Iron Pipe & Foundry Company	100,841	851,592	.....	.....
U. S. Steel Corporation	‡100,791,279	185,695,359	2.24	16.62
Westinghouse Air Brake Company	1,412,490	.....	1.00	.....
White Motor Company	*4,837,319*	2,410,014	.....	4.82
Worthington Pump & Machinery Corporation	*188,630*	2,030,923	.....	7.85

* From this amount $345,000 had been reserved for income and excess profits taxes.
† Capital stock (issued) preferred $2,000,000; common $15,800,000.
‡ Taxes deducted but including interest on bonds of subsidiary companies.

Who Gets Cement Contract When Bids Are Uniform?

Atlas Co. Says Determining Factors Are Salesmanship and Service—Personal and Institutional

Public interest in cement prices and their uniformity is so keen that *Engineering News-Record* asked the Atlas Cement Co. to state "the considerations aside from price that determine the award of a cement contract." L. R. Burch, assistant to the president, replies:

"The answer must be given in one phrase—salesmanship and service—personal and institutional. This is a very broad way of treating the matter, however, and in order to make clear just what cement salesmanship comprises and at the same time illustrate the keenness with which cement manufacturers follow up possible business, it might be well to note briefly the means employed in connection with a recent contract which is a typical case.

"Bids were submitted in the usual way and immediately the machinery of the sales department was set in motion long before the date on which the bids were to be opened.

"The purchasing agent was seen by the local salesman in charge of the territory in which the buying was to be done and an investigation was made of the prospective buyer with a view to discovering possible points of reciprocity and personal connections.

"Conditions of delivery were carefully looked into to see if more satisfactory shipments could be made by us than by a competing company. In this connection the matter of car supply, rail routing, junction points and time in transit play an important part.

"As a further service, the sales force, aided by the technical department lent valuable assistance to the purchaser in locating convenient sand and gravel deposits, and giving information on local storage and delivery facilities.

"An effort was made to locate the real buyer, for it frequently happens in the letting of large contracts that the purchasing agent does not have the final say and methods have to be employed which differ radically from those otherwise employed. As a matter of fact, each contract presents problems which are unlike any previously encountered; consequently there is no one method which will fit every case.

"The matter of storage and production capacity at the manufacturer's plant must also be considered and brought to the purchaser's attention, for with a heavy demand for cement for public work, the ability of the company to carry sufficient stock on hand to cover any call for deliveries, is of the greatest importance.

"The heads of the Sales Department naturally have knowledge of all bids and not only give their attention to the direction of the solicitation, but where they believe it will be to advantage to take up the matter personally, lending the prestige of their positions and ability to supplement the efforts of the local and general salesmen.

"The point I want to bring out is that in the efforts to make a sale in the face of such strong competition as prevails in the cement industry, nothing is left undone by a sales department costing more than a million dollars a year. That this is the case will be maintained by architects, engineers, contractors and dealers who have been in any way connected with cement jobs and who have had occasion to remark the active manner in which a prospective buyer is pursued by each bidder.

"Which gets us back to the short form of answer, that the consideration determining the award of a cement contract, where the quality is standard, the market highly competitive and the prices in consequence fairly uniform, are salesmanship and service of a highly developed character."

Cost To Test Cement and Inspect Fabricated Steel

Recent bids received by the Wisconsin Highway Commission for material testing in 1922 give a range of 1¼ to 2c. per bbl. of cement, and 20 to 75c. per ton of fabricated steel inspected in the shop. The seven bidders and their bids follow:

	Robt. W. Hunt Co. Chicago	Gulick-Henderson Co. Chicago	Pittsburg Test. Lab. Chicago	Amer. Bur. of Insp. & Tests Chicago	Walter H. Flood Chicago	Minnesota Test. Lab. Duluth	Transcontinental Eng. Co., Chicago
Cement: Bid Per Bbl.							
1,200,000 bbl.	$0.019	$0.0174	$0.02	$0.0165	$0.014	$0.0137	$0.0125
600,000 bbl.	.02	.0178	.02	.017	.0165	.0144	.02
Shop inspection of steel fabrication:							
Milwaukee	$0.40 ton	.70	.40	.35	.30	.....	.20
Wausau	.90	.75	1.60	.45	.35	.....	.25
Chicago	.40	.65	.40	.35	.30	.....	.20
Minneapolis	.40	.75	.40	.35	.35	.....	.25

"How High Are Cement Prices?"

Blaine S. Smith, general sales manager of the Universal Portland Cement Co., Chicago, contributes to the discussion, "How High Are Cement Prices?" which was published in this section, Feb. 23 issue:

"There is one point which we believe you should take into consideration in making comparisons between cement prices as of different dates, and that is the discount for cash in ten days from date of invoice in effect as the dates affected. This discount for prompt payment has varied from time to time. Prior to January, 1914, the discount was 1c. per bbl.; at the time of peak prices in 1920 it was 5c. a bbl.; it is now 10c.

"It is obvious that as the present discount is ten times the discount in effect in 1913, when present prices are compared with 1913 prices the discount is an important factor. For example: in Table I, p. 340, price on cement f.o.b. mill is shown as $1.70 to-day, as $2.10 at the peak in 1920, and the per cent decline since peak as 19 per cent. Applying the discounts, the present price becomes $1.70 less 10c. or $1.60, and the peak price becomes $2.10 less 5c. or $2.05. The per cent decline since peak therefore is 22 per cent instead of 19 per cent as shown in the table.

We note the following discrepancies in prices quoted in Table I, on p. 340: price of $1.70 f.o.b. mill, which you show as being in effect six months ago, should read $1.90; price of $1.80 f.o.b. mill, one year ago, should read $1.90; also price of $2.00 f.o.b. Chicago, one year ago, should read $2.17. With reference to Table II, on p. 341, you show the average price f.o.b. Chicago, for 1920 as $2.01, whereas in Table I, you show the peak price as being $2.37 for the same year. We have arrived at an average of $2.17.

"Again in Table II, p. 341, the average price at Mid-West mill is shown as $1.05 in 1913 and $1.70 in 1922, the per cent change being 62 per cent. Our average price at Buffington in 1913 was $1.07, but using the figure in your table of $1.05 and deducting 1c. discount, the 1913 price becomes $1.04; and deducting 10c. discount from $1.70 the 1922 price becomes $1.60. The increase from $1.04 in 1913 to $1.60 in 1922 is 54 per cent instead of 62 per cent as shown in the table.

"A gratifying feature of your article is that in Table II in showing prices f.o.b. Chicago you explain in footnote that these prices necessarily include freight between mill and Chicago and that the figures consequently are affected by the freight increases. A point that should be but unfortunately sometimes is not obvious to the reader is that an untrue relation is shown if delivered prices as of different dates are compared when there has been a change in the freight rate in the interval between the two dates."

Eight Cement Companies Receive Wisconsin Contracts

Contracts for 1,501,000 bbl. of cement to build the 1922 program of roads in Wisconsin have been apportioned as follows among eight different companies submitting bids on Feb. 28: Sandusky Cement Co., 75,000 bbl.; Lehigh Portland Cement Co., 197,000 bbl.; Alpha Portland Cement Co., 127,000 bbl; Petoskey Portland Cement Co., 16,000 bbl; Huron Portland Cement Co., 7,000 bbl; Northwestern States Portland Cement Co., 6,000 bbl.; Marquette Cement Manufacturing Co., 400,000 bbl; Universal Portland Cement Co., 673,000 bbl.

A. R. Hirst, state highway engineer, in a statement to the newspapers, says that at a conference March 7 with the representatives of the counties, the latter favored going ahead with the program. They urged that the difference in the price of cement expected and actually received in the bids was so small an amount per mile that the employment situation justified proceeding with all important work. The State Highway Commission expressed the opinion in the conference that the boycott had been carried as far as it was profitable to carry it. The price paid in 1922 averages $1.41 mill net per bbl. while the average mill net for 1921 was $1.80. Bids on construction this year are lower than expected, averaging not more than $25,000, including grading and culverts, for 18 ft. concrete roads.

Work for 500 Men

The $2,500,000 O'Shaughnessy Dam to be constructed by the city of Columbus, north of Dublin, Ohio, on the Scioto River, is expected to furnish work for 500 men. Bids will be opened April 20 (see Construction News). The dam, of concrete, will be 1,400 ft. long by 70 ft. high, with a bridge on the top of the structure.

Unemployed Work Out Own Employment Service

Committees recently made up of unemployed engineers in Chicago to canvass the field and explain that the Western Society of Engineers maintained a free employment service accomplished little, says the *Journal* of the society. These members found employment so soon that they had little opportunity to accomplish results. The *Journal* concludes that unemployment conditions are undeniably improving, especially in the Western states.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of March 2; the next, on April 6.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb	$2.63	+$3.35	$4.00	$2.63	$2.66	$3.50	$3.10	$3.25	$3.75
Structural rivets, 100 lb	3.50	+3.90	5.50	3.43	3.90	+4.55	4.50	3.75	6.50
Reinforcing bars, ¾ in. and larger, 100 lb	2.53	+3.25	3.50	2.53	2.56	3.42½	2.75	3.25	2.75
Steel pipe, black, 2½ to 6 in. lap, discount	61%	68%	45%	59½%	61.9–5%	44%	58.8%	53%	35.10
Cast-iron pipe, 6in. and over, ton	47.30@48.30	+40.00	48.30	43.10@44.60	46.00	52.00	48.00	52.00	55.00
Concreting Material:									
Cement without bags, bbl	2.40	2.39	2.25	1.94	2.24	2.90	2.73	2.94	2.40
Gravel, ¾ in., cu.yd	1.75	1.85	2.25	2.00	1.50	2.50	2.25	1.50	1.50
Sand, cu.yd	1.00	1.15	2.25	2.00	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.75	1.90	2.73	1.60	2.25	3.50	2.25	3.00	2.00
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	49.00	37.00	−33.50	43.00	38.00	34.75	28.00	20.00	.....
Lime, finishing, hydrated, ton	15.80@16.80	18.00	25.00	18.00	29.00	24.00	22.00	27.00	21.00
Lime common, lump, per bbl	2.75@3.48	1.25	2.50	1.40	1.40	2.70	1.75	2.75	11.00
Common brick, delivered, 1,000	19.40@19.90	8.75	11.15	11.00	15.00	12.00	15.50	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	.07975	.115	.0821	.0752	.08	....	.10	.20
Hollow partition tile 4x12x12, block	.11120	.06525	.115	.0657	....	.10	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal	−.84@.87	—.81	.109	.97	—.93	−1.08	1.04	.86	1.05
Common Labor:									
Common labor, union, hour	.60	.35	.....	.72½	.....	.50@.55	.56¼	.50@.60	.....
Common labor, non-union, hour	.....	.20	.25	.35@.40	.40@.50	.35@.40	.47½@.56	.50	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or − signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement and steel pipe delivered to contractors on job. Gravel ready mixed $2 per cu.yd.

Chicago quotes hydrated lime in 50-lb. bags; common lump line per 180-lb. net.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed store quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to contractors in yards at San Francisco. Lumber price is for No. 1 fir, common.

Seattle quotes on Douglas fir instead of pine. Common lump lime per 180-lb. net.

Montreal quotes sand, stone, gravel and lump lime per ton. Lime and tile are delivered; cement, sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 96.87 cents). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net.

Changes Since Last Week

The outstanding features of the week are centered in an advance in steel and cast-iron pipe prices at the warehouses and a general tendency downward in linseed-oil quotations throughout the country. An increased demand for finished steel products has characterized the market throughout the week. Pittsburgh mills, with few exceptions, are holding firmly to the asking price of $1.50 per 100 lb. on structural shapes, plates and reinforcing bars. Only in exceptional cases, involving large tonnages, is the quotation of $1.40 easily obtainable. Atlanta quotes advances of 10c. per 100 lb. on steel shapes, structural rivets and reinforcing bars. Denver quotes a rise of 30c. per 100 lb. on rivets. Structural steel, delivered by rail, is quoted at $63.30 f.o.b. Seattle; water deliveries at $52.60 per ton. Cast iron pipe is quoted at $52 as against $50 per ton with prices tending upward. Seattle also reports a falling off in demand for steel and cast-iron pipe but increasing lumber demand with prices holding firmly. Cast-iron pipe is quoted at $40 as against $37.63 in Atlanta and at $52 as compared with $50 per ton in Seattle one week ago.

A drop of 50c. per M. ft. is quoted in yellow pine lumber in Dallas. A total of 378 mills reporting to the National Lumber Manufacturers' Association for the week ending Mar. 11, show 179,779,597 ft. of lumber cut; 179,939,737 ft. shipped and orders for 168,851,556 ft. b.m. Production stands at 22.5 per cent; shipments at 23 per cent and orders at 28 per cent below normal.

Common brick prices remain firm in all important centers. The situation in New York has been improved by the arrival of seven more barge loads of Hudson River common brick, bringing the total up to 15,000,000 received from the Haverstraw district between Jan. 1 and Mar. 15.

Linseed oil, quoted at a drop of 13c. in Atlanta; 5c. in Minneapolis and 6c. per gal. (5 bbl. lots) in Denver.